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THE IRRIGATION AGE

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THE IRRIGATION AGE
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SPECIAL FEATURES

Why State and Federal Government Should Co-operate

Primer of Irrigation

State Progress in Wyoming

Silas Thornapple on "Gittin' A Home"

CHARLES A. COX
CHGO.

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D. H. ANDERSON, Editor.

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

MAXWELL-TONS' "BRAYS" ARE BONNIE.

When it comes to advertising, Maxwell is up to date. Through his news bureau he sent out to the newspapers, three weeks in advance of the meeting of the Irrigation Congress, the speech he delivered before that body. In the copies thus sent out appeared the following, in parentheses: "The congress was electrified"; "This eloquent outburst brought the delegates to their feet"; "The great champion of irrigation was applauded to the echo"; "The audience went wild."

The delegates who were present, heard the speech, and noted the oppressive silence with which his "outbursts of eloquence" were received, are having a merry laugh at the newspapers that were gulled into printing the "bureau's" advance reports.—*The Arizona Blade.*

Maxwell, Newell, Hitchcock & Co. The combination known as Maxwell, Newell, Hitchcock & Co., are pushing work on the Tonto dam in Arizona for fear that something may happen to stop it before they get under full headway. Some day the inside history of all this work will be written and some day, also, the farmers who are signing an agreement to pay $15 on each acre served by this dam, will awaken. Perhaps it is, on the whole, a good thing to give this combination plenty of rope. Perhaps—you probably know the old story about the Romans on the sand hill.

Observations. The editor of IRRIGATION AGE returned recently from an extended trip through Colorado, New Mexico and parts of Arizona and old Mexico where he secured a lot of data for future articles in these columns. The work along lines of irrigation controlled by private capital was never more active than at present. Large sums of money are being expended by promoters of projects independent of government assistance. One striking feature observed in Colorado, New Mexico and Texas is the unusual attention given to under flow and the large amount of new work projected along the line of pump work for irrigation. This is particularly noticeable along the valley of the Rio Grande, both in New Mexico and Texas.

The splendid work accomplished by the faculty of the New Mexico College of Agriculture, at Mesilla Park, is attracting wide attention throughout the west, as well as in all other sections where lifting a large volume of water from an underground flow is important to agricultural or other pursuits.

The pumping plant at this station is under the charge of Professors John J. Vernon and Francis E. Lester. It is our intention to begin with our December number the publication of bulletin No. 45 issued by this station. This bulletin, which is finely illustrated, will run through several numbers of THE AGE. Professor Luther Foster, president of the college and director of the station, is very much interested in this line of work and offers every encouragement to Professors Vernon and Lester in their investigations.

"Silas." Read what Silas Thornapple has to say in another column concerning "Ozone George" and "home gittin.'"

J. A. Charter, M. E. We are presenting in this issue a portrait of Mr. J. A. Charter, of Fairbanks, Morse & Co., Chicago, who acted as one of the delegates from Illinois to the Eleventh National Irrigation Congress. Mr. Charter is an expert on pumping machinery for irrigation purposes and is very much interested in work along these lines, which is now receiving such general attention throughout the west. Fairbanks, Morse & Co. are making an active campaign through Mr. Charter and their many branch houses throughout the west for their share of this business.

Volume Nineteen. With this issue we appear as Number 1 of Volume 19 of THE IRRIGATION AGE. One year ago the size of this journal was changed from standard magazine to its present form. This change was made to accommodate larger illustrations and permit us to present a more attractive front to our readers. This with other improvements has very materially aided us in building up a much larger subscription list and enables the AGE to more easily maintain a position which by age it is rightfully entitled, viz., that of the leading and best irrigation magazine of the world. The circulation of this magazine has increased from 9,000 to over 22,000 copies, and all within a period of two years. This increase is due largely to the unusual interest throughout the country in irrigation matters as well as to the improvement in quality of matter furnished our readers.

"Modern Irrigation." Beginning with its issue of November, *Modern Irrigation,* published at Denver, Colo., and second in point of age to THE IRRIGATION AGE, passes into new control. This magazine, which is the successor of *The Irrigation Era, Arid America,* and a number of other western publications devoted to irrigation and agriculture, will be published by The Modern Irrigation Publishing Company, Denver, of which D. H. Anderson, of THE IRRIGATION AGE, is president, and George W. Wagner, a well-known publisher of Denver, is secretary and treasurer.

In this connection it may not be out of place to say that advertisers desirous of developing trade among irrigation farmers, irrigation corporations and dealers in implements, vehicles and accessory lines throughout the western states, will find these two publications the VERY BEST medium. All correspondence concerning advertising, etc., may be directed to the D. H. Anderson Publishing Company, 112 Dearborn street, Chicago.

Coddling Moths and Canker Worms. It was the coddling moth that lost Utah the prize of the Clark loving cup at the exhibition connected with the recent Eleventh National Irrigation Congress at Ogden, Utah. Dosch of the awarding committee said: "It was too bad, Utah ought to have the cup, but it will teach their fruit growers a lesson."

Oregon and Washington felt barred from competing for the cup on account of the same coddling moth.

It will indeed be a lesson to fruit growers, and to apply the lesson to matters equally as important, adding the canker worm, likewise a destructive agent, we wish to say that there is nothing of good, beneficial, or for the public welfare that is not tainted by coddling moths and canker worms, constantly gnawing, gnawing, and depositing baneful germs to ripen and corrupt the whole mass.

The majority of the delegates to the Eleventh National Irrigation Congress now understand clearly the deleterious influences secretly at work to destroy the universal objects and aims of their congress, and turn it into a cover, disguise, backing for the private designs of personal schemers, who are constantly quoting the maxims of honesty, morality, public good, and President Roosevelt while undermining all of them in the dark.

Let no delegate forget the truism of the wise bard: "The devil can cite Scripture for his purpose," and watch the trend of events as they gradually center upon the Twelfth National Irrigation Congress to be held at El Paso in 1904. Observe the cunning work that will be done during the coming year to gain the control of that Congress and debauch it from its purpose with a private scheme, a cover for land and water grabbing syndicates. And while these coddling moths and canker worms are busily engaged in destroying the fair fruit of the irrigation law, observe, also, the "spraying" THE IRRIGATION AGE will apply to them in accordance with the suggestion made by Commissioner S. T. Whitaker, director-general of the Utah exhibit at the St. Louis exposition.

El Paso, Texas. The editor of THE IRRIGATION AGE has recently returned from an extended southwestern trip, on which he visited Colorado, Kansas, New Mexico, Arizona, Texas and parts of Old Mexico. His objective point on leaving Chicago was El Paso, Tex., with a view to studying the possibilities of that city as a point for holding the next Irrigation Congress, and to give our readers some idea of the advantages of that city so far as handling a large crowd of people is concerned.

Our impressions of the city of El Paso leads us to believe that it is destined to become a great commercial metropolis of a vast region. Nature has given her the position, and the laws of trade, like the laws of nature,

will always assert themselves. Her position relatively and very significantly is equi-distant from the great cities of Mexico, San Francisco, St. Louis, New Orleans, Kansas City and Galveston, the distances from each of these cities being about 1,100 miles. It can readily be seen that this distance is sufficient to permit for El Paso the development of a large wholesale or jobbing trade, and that it is too far from each of these points to come into competition or rivalry with any of them, and as she has direct railroad communication with all of them, there is no doubt but that as her jobbing trade develops, and the present number of manufactories which are already established is increased, she will control a goodly share of the trade of her natural field. All of the cities named are competing for her trade and for the trade of Mexico through her, which naturally makes El Paso a great railway center. The commerce of Chihuahua, Durango, Zazatecas and other Mexican states which are cut off from the ocean by high mountain ranges, is now passing through that city.

The vast extent of territory tributary to El Paso, and her position as the pathway of the immense trade that will in the course of time be carried on between the two republics and the states of Central and South America, give her, to the observer, a commercial future which the mind of the business man may readily grasp.

In point of destiny it occurs to us that El Paso is entitled to rank with any of the great cities mentioned above, and by the time she is as old—and remember now that we are speaking of the new El Paso—as Denver or Kansas City, she will equal, or it is no stretch of the imagination to say that she may outstrip them.

El Paso is entitled, it seems to us, to consideration by investors throughout the country, as there is great opportunity for the investment of money in business buildings as well as residences. Rents in the city are at the present time extremely high, owing to shortage of available home property. Five room cottages are renting today for $35 and $40 per month.

One strong feature that the average visitor at El Paso perhaps overlooks is, that the Mexican Central Railway and its 1,225 miles between there and the City of Mexico, passes through twenty-one cities having a population of over 1,000,000 inhabitants. Lying, as she does, on the American side of the Rio Grande river in the center of a great district including western Texas, southern New Mexico and eastern Arizona which is directly tributary by reason of the network of railways which center there, her position from a commercial standpoint is assured. The railways entering this city are the Atchison, Topeka & Santa Fe, the Southern Pacific, Texas Pacific, Galveston, Houston & San Antonio, the Mexican Central, the El Paso & Southwestern, the Chicago, Rock Island & Pacific, and what is known as the Bisbee Railway, a line reaching over into the mining districts of Arizona, which has opened up a territory of remarkable richness and wealth, which will be entirely dependent on El Paso for supplies.

A representative of Irrigation Age is at present in El Paso with a view to prepare a finely illustrated article showing the principal buildings, etc. El Paso is well equipped with hotels and is amply able to entertain the 2,000 visitors which her hospitable citizens will welcome at the time of the Twelfth National Irrigation Congress in November, 1904.

Twin Falls Project.

The "Twin Falls Project" is one of the stupendous engineering feats that little is said about, because they seem impossible. Nevertheless, it is purposed raising Snake river, Idaho, by means of dams placed at a point in the rvier about twenty-five miles above the world-famed Shoshone Falls. This will enable the waters to be distributed over a tract comprising 244,000 acres of waste sage brush land on both sides of the river.

The work is already well under way, the Nelson Bennett Company, of Tacoma, Wash., who are constructing the ditch, having twenty sub-contractors at work, at intervals one mile apart below the town of Milner.

Is Irrigation An Evil?

Few are found these days who oppose the steps taken by the National Government to encourage irrigation in the arid West. Yet there are some who assert that extensive irrigation will result in too much competition for the farmers of the humid sections. They argue that the reclaiming of, say, a hundred million acres of arid land with the consequent entry of their products into the markets will have the inevitable effect of reducing prices for all. But they do not stop to think that these results are rendered impossible by the fact that the population of the United States is growing faster than farm expansion is making headway; the market for farm products is constantly enlarging instead of diminishing. Another thing: Irrigated soil and humid soil are distinguished as a rule by distinct kinds of crops, peculiarly adaptable to each. The former caters more to the raising of alfalfa and fruits; the latter principally to wheat and other grains. Irrigated lands are able to grow almost anything, but they are far too valuable to devote to the cultivation of grain when more money is made in other products. For this reason the humid regions will forever be left free to raise their wheat and corn and other products without much fear of competition from districts reclaimed by artificial watering.

The great stock raising advantages of the West are made possible by the existence of irrigation which permits the growing of alfalfa and other splendid fodder plants. Range is becoming very much restricted and recourse must be had to pasture.

WHY AND HOW STATE AND FEDERAL GOVERNMENT SHOULD CO-OPERATE FOR IRRIGATION.

F. H. RAY, HELENA, MONT.*

Reclamation of the arid West will be hastened by intelligent co-operation of State and Federal Governments. State and nation have separate interests as well as a common interest in such reclamation; each have work to do in connection therewith that the other can not perform; there need be no conflict of authority or complications between them, and wise state laws will remove many existing obstacles.

The national irrigation law was a long advance step, for which much credit is due President Roosevelt, the National Irrigation Association, Elwood Mead, and many others. The idea held by some, however, that the entire work of reclamation should henceforth be left to, or will be accomplished by the Federal Government, is wrong. Government funds are not available for the stupendous task; and reclamation, as in the past, will continue to be accomplished most largely by private enterprise.

The national irrigation law wisely recognized the domain and function of the State by expressly providing in Section 8, "that nothing in this Act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any state or territory relating to the control, appropriation, use or distribution of water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this Act, shall proceed in conformity with such laws."

President Roosevelt in his first message to Congress grasped the situation and indicated what the states *should do.* He said: *"The security and value of the homes created depend largely on the stability of titles to water;* but the majority of these rest on the uncertain foundation of court decisions rendered in ordinary suits at law. With a few creditable exceptions the arid states have failed to provide for the certain and just divison of streams in time of scarcity. Lax and uncertain laws have made it possible to establish rights to water in excess of actual use or necessities. In the arid state the only right to water which should be recognized is that of use. In irrigation this right should attach to the land reclaimed and be inseparable therefrom. Granting perpetual water rights to other than users, without compensation to the public, is open to all the objections which apply to giving away perpetual franchises to the public utilities of cities."

Secretary Wilson, in his 1901 report, said: *"Whatever aid Congress extends should be conditioned on the enactment of proper irrigation codes by the states* and made to promote the greater efficiency and success of such laws rather than interfere with their operation." He thus clearly recognized the right relation between nation and state.

VITAL IMPORTANCE OF WATER TITLES.

With land abundant and water scarce possession of water is the keystone in our western agricultural arch, or as stated by President Harrison, "Whoever controls a river practically owns the land it waters, no matter who has title to land." Under such conditions the title to water is of vital importance and just laws governing its ownership and use are the necessary foundation for agricultural development.

Unfortunately this phase of the subject was, excepting in Wyoming, Nebraska, and Colorado, neglected until 1898. Attention was then called to it in Agricultural Department Bulletin No. 58, by Elwood Mead, Chief of Irrigation Investigation. Since then that office has in other bulletins, notably Nos. 86, 96, 100 and 104, diffused much valuable information gathered by competent investigators in several states and demonstrating the urgent need for state legislation. Efforts for such legislation was successfully made in Utah and Idaho last winter, but failed in California and Montana.

Let us consider, very briefly, *existing conditions as to water titles.* Titles to water should be as definite, as easily ascertained, as secure and free from litigation as land titles; this much is due the settler, the distant investor, and is requisite for the general welfare. Instead of this desirable condition there prevails in most of the arid states indefinite, insecure titles, excessive decrees, streams over-appropriated, many localities where it is easier to build the ditch than ascertain its right to water, where irrigation and litigation are synonymous.

A recent careful investigation in one state, which has more water and less irrigated land than several sister states, disclosed 26,146 recorded claims for water, less than 10 per cent of which had been adjudicated. During the current year there had been water litigation in twenty out of twenty-six counties, water suits were pending in seventeen counties and water litigation had been increasing in most counties. Cases with 400 defendants were reported. One county reported a large part of its criminal cases and two-thirds of its civil cases were water controversies. In one small valley about a quarter of the water right had been adjudicated at a cost of $25,000. In that same valley of fifty ditches taking water to hundreds of farms, not one right had been determined, nor did a farm on those fifty ditches have a clear title to its water supply. At present *court decisions are seldom final* and the law does not afford adequate means of protecting a right after adjudication, except through another lawsuit. I can cite streams in different states where titles have been quieted three and four times in ten years, and other suits to again settle have just been instituted. It is a question whether the water rights or litigants will first be put to rest.

Estimate, if you can, the obstacles which such conditions are to irrigation growth and the burden imposed upon tax payers by the ever increasing litigation. Think of the opportunity afforded for acquiring excessive decrees, establishing water monopoly, depriving prior settlers of rights and oppressing future tillers of the soil. Consider the effect on the inquiring investor. Too often he quits a contemplated enterprise in disgust. Foregoing are a part only of the evils, ever growing, due directly to lack of proper supervision and control. Is not the urgent need of a remedy apparent? Does not agricultural development require an early and just adjudication of conflicting claims and thereafter adequate supervision and control of water? Should not this Congress heed the need and devote a part of its deliberations to this subject?

As a basis for such discussion let me mention, very briefly, remedies tried and proposed. Supervision and control may be by community, by state or by nation. Utah tried community or district control as early as 1865, has found it unsatisfactory and adopted state control. In California the Wright district law has not

* Paper read before Eleventh National Irrigation Congress

been successful and a very able commission, on which served ex-Judge Works, President Wheeler, of California University, and President Jordan, of Stanford; Mr. F. H. Newell and Mr. Elwood Mead, representing the United States Department of Interior and Agriculture, respectively, proposed legislation to establish state control. Colorado began to exercise control in the division of water fourteen years ago. Wyoming when admitted a state in 1890 adopted a comprehensive irrigation code, providing for state control and supervision; five years later Nebraska enacted a code substantially like Wyoming's. After twelve years' trial in Wyoming and seven in Nebraska, irrigators and officials in both states testify that the law is very satisfactory, that it has served to adjudicate about 5,000 claims, outside the courts, at a minimum of expense and with such satisfaction to water users that only about a dozen appeals have been taken from the State Board of Control to the District Court. The late Governor Richards wrote me, "This law has been the means of preventing that vast and costly litigation which, since the inception of irrigation, has characterized the determination and settlement of claims to water." Under state control there has been adequate protection to prior users, prevention of litigation, waste, and over-appropriation, stream measurements have been made, water right records perfected, made easily accessible, and other valuable data obtained. Wise men profit by the experience of others and we ought to heed well the results of state control in Wyoming and Nebraska. The Wyoming law was highly commended by Mr. Geo. H. Maxwell in *National Advocate,* and also in a brief filed before the California Supreme Court. Recently Mr. Maxwell has opposed state laws and publishes in a plan of campaign for the National Irrigation Association opposition to schemes for state control. I have no wish to detract from any credit due Mr. Maxwell and the association for aiding national irrigation; my sole purpose is to present views on supervision and control which are held by a large number of practical irrigators who have labored as long, as ardently and as ably as any one to advance irrigation.

It was alleged in printed matter sent to the legislators of one state that complications with the Government would result from state laws. But it was not shown how these would occur, nor why the National Government would be embarrassed by carrying out the recommendation made by President Roosevelt, Secretary Wilson and the Government expert, Mr. Mead. Inasmuch as the code proposed by the California commission, whose published report was signed by Mr. F. M. Newell and Mr. Mead, contained a section apparently designed to prevent complications, and that identical section was a part of the proposed Montana law, the opposition had no foundation for its fears. That section reads: "Sec. 5. Subject to Laws of Congress for Storing Water: All rights to water flowing over, on or across Government lands of the United States, and all flood waters acquired under this act or previous laws of the State shall be subject to any of the acts of the Congress of the United States providing for the storage, conservation and distribution of the flood or other unappropriated waters of such streams for public use, and the Government of the United States may, in the interest of the public good, acquire right and title to all or any part of the waters of any of the streams of the State in the furtherance of any such enactments of Congress, by paying to any owner of water rights reasonable and just compensation therefor, to be arrived at by agreement of the parties if possible; if not, by condemnation proceedings, as provided by law." Thus possible complications were guarded against.

Instead of state control, Mr. Maxwell, in November, 1902, issue of *Forestry and Irrigation,* advocated water users' associations for each drainage basin and applied the term *"Home Rule in Irrigation"* to his plan. His idea of "home rule," however, was that "Every drainage basin should do business with the *National* Government as a unit," the water users of which "can adopt any rules or regulations desired or approved by the Secretary of the Interior." Now I submit, with all deference to the gentleman, that such a plan is not "home rule" but government of the water user from and by the department at Wsahington. The term is misleading and the plan is not practicable, expeditious, or simple. For purpose of supervision under state control the division by hydrographic or drainage basins has been pursued in Wyoming, Nebraska and Colorado. The objection to Mr. Maxwell's plan of a water users' association for each basin is that many of these basins are hundreds of miles long and all the irrigators over a vast area, with their conflicting interests, will not gather in a town meeting and agree upon an organization and a representative to be sent to Washington. But grant for argument that they did. How long would Congress or any department listen to the troubles of each drainage basin? Would or could Washington officials bring order out of the confusion of thousands of conflicting claims? If this method be applied to the sixteen arid states there will be from sixty to seventy-five drainage basins for attention. Who would be served first? How much delay would there be? What would be the expense for such long range adjudication and who would bear it?

Remember there is involved recorded water rights not yet adjudicated and unappropriated water in more than a dozen states worth more than a hundred millions of dollars; for this liquid wealth there are thousands and thousands of conflicting claims. What an opportunity for greedy claim agents would be created by an attempt to adjudicate these claims and control a division of the water from Washington. It would necessitate a special department to do business with which the individual or company would require an attorney at so many dollars per claim. Would not the water user "get off" at the door of a Washington claim agent? How many dollars and how much time would he expend?

Contrast this with the method in Wyoming and Nebraska, where the *means of adjudication are brought to the water user,* the fee paid is less than $5.00, where prior rights are protected, and peace prevails instead of violence and litigation. Does not the results in these states prove that justice, expedition, and satisfaction are far more easily attained under state law than by the proposed plan?

It has been imagined that state codes meant much political patronage with "corps of ditch tenders and appointees." The fact is that under the Wyoming law there is appointed a state engineer and superintendents for each of four basins, a total of five. As there is necessity these basins are subdivided into such water districts as will best secure protection to claimants and economical supervision on the part of the state; in

the district a water commissioner is appointed, but he does not begin work until there is a written demand by two or more ditch owners. If the lawmakers wish these offices can be made elective. Suppose they are appointive, is there more danger when appointments are made by state authority instead of national or less? Is the state government less competent and trustworthy than the National Government. If an appointee proved unfit could or would removal be quicker from Washington than the state capital?

An additional reason for state control is that the arid states have millions of acres of land granted to state institutions the value of which land is affected by laws relating to water; the state should guard and advance its interest in such lands.

Should we not heed the suggestions of President Roosevelt and Secretary Wilson for proper state codes, the experience of Wyoming, Nebraska and Colorado with state control, the recent legislation for state control by Utah and Idaho, and the strong sentiment for such control in California, Montana and other states?

The opposition to state laws is not based on experience nor supported by valid reasons. State control by adjudicating conflicting claims, by supervising the construction of works, the appropriation and division of water, by co-operating in measurement of streams and obtaining other data will ably supplement the work of the National Government. The task of reclamation requires the united efforts, the intelligent co-operation of both State and Federal Governments; action along these lines will hasten the benefits we all desire.

It is the impression of those most deeply interested that if outside influences such as represented by Mr. Maxwell and his straggling fellows should be relegated to the rear, where they belong, the trouble would end.

THE BARNES WELL, SAN ANTONIO, TEX.

In this issue are shown three views of the famous Barnes well near San Antonio, Tex. This well has a flow of three million gallons in twenty-four hours with a pressure of thirty-five pounds. Engineer Smith, of Waco, Tex., estimates that this well will irrigate easily five hundred acres of land once in ten days.

Mr. Barnes is a prominent hotel man of Texas and informs us that he will eventually dispose of his hotel interests and devote his energies to farming by irrigation. The 160-acre tract on which this well was sunk is said to be worth at the present time $1,000 per acre. The same land without water would not sell for to exceed $10 per acre. The land under the new arrangements will be developed for truck farming.

Plants grow so luxuriantly in the Valley of the Rio Grande, that many of its farmers have little idea of what is meant by a commercial fertilizer.

THE PRIMER OF IRRIGATION.

BY D. H. ANDERSON.

CHAPTER VII.

PLANT FOODS—CEREALS—FORAGE PLANTS—FRUITS—VEGETABLES—ROOT CROPS.

Plants of every variety are very hearty feeders as a rule; in fact, if a plant be furnish with unlimited quantities of its proper food, and the environments of soil and climate are favorable, it will increase its bulk to enormous dimensions; the case is the same with fruits.

DAWSON COUNTY NEBRASKA DELEGATES TO ELEVENTH NATIONAL IRRIGATION CONGRESS, OGDEN, UTAH.

Sir Humphrey Davy introduced plants of mint into weak solutions of sugar, gum, jelly, etc., and found that they grew vigorously in all of them. He then watered separate spots of grass with the same several solutions, and with common water, and found that those watered with the solutions throve more luxuriantly than those treated with ordinary water. From this it may be reasonably inferred that different organic substances are taken into the circulation of plants and then converted by them into its own substance, or acts as food and nourishes the plant. Of course, it will be understand that by "plant foods" are meant whatever material tends to make the plant grow to maturity.

We have learned that plants absorb carbon in the shape of carbonic acid, and the part ammonia plays in the plant economy. Indeed, ammonia is actually present in the juices of many plants, for example: in beet roots, birch and maple trees, etc. In tobacco leaves and elder flowers it is combined with acid substances. It is also an element in the perfume of flowers, whence the value of barn yard manure to supply that element.

Nitric acid is invariably present in common, well known plants, in combination with potash, soda, lime, and magnesia (nitrates). It is always contained in the juices of the tobacco plant and the sunflower. The common nettle contains it and it is present in barley in the form of nitrate of soda.

Like ammonia, nitric acid exerts a powerful influence on growing crops, whether of corn or grass. Appied to young grass or sprouting shoots of grain, it hastens and increases their growth and occasions a larger production of grain, and this grain is richer in gluten, and therefore more nutritious in quality.

As showing the power of a plant to select its own food: if a bean and a grain of wheat be grown side by side, the stalk of the wheat plant will contain silica and that of the bean none. The plant intelligence, or instinct, so to speak, knows what it wants or needs, and it takes what it requires, rejecting everything else. Plants have also the power to reject through their roots such substances as are unfit to contribute to their support, or which would be hurtful to them if retained in their system. Knobs, excrescences and exudations may often be seen on the roots, stems, and even the leaves of plants, which many think are due

BARNES' WELL SHOWING STRENGTH OF FLOW.

to the ravages of some insect, but which are nothing more than the natural effort of the plant to get rid of some obnoxious or harmful substance in its system. When the plant's blood is out of order its nature attempts to cure it by forcing the dangerous substance or matter to the surface, as does the animal system under like circumstances.

Even the germinating seed is a chemical laboratory, inasmuch as it gives off acetic acid, or vinegar, which dissolves the inorganic material in its vicinity and returns with it in a condition to build up and nourish the plant.

The chemical compounds produced by the juices of all plants may be said to be innumerable. Most of them are in such small quantities that it would scarcely be worth while to consider them, but some are of a highly remedial quality, as quinine from Peruvian bark, morphine from the opium of the poppy, salicine from the willow, etc. All the cultivated grains and roots contain starch in large quantities, and the juices of trees, grasses and roots contain sugar in surprising quantities. The flour of grain contains sugar and two other substances in small quantities, namely: gluten and vegetable albumen, which are important nutritive substances. Sugar is also present in the juices of fruits, but is associated with various acids (sour) substances, which disappear altogether, or are changed into sugar as the fruit ripens.

WOODY FIBER, OR LIGNIN.

To manufacture the foregoing chemical compounds nature requires a huge structure, an enormous space

ANOTHER VIEW BARNES' WELL, SAN ANTONIO, TEX.

when compared with the product turned out. More than one has wondered why a monstrous oak should produce so ridiculously small a fruit as an acorn, and a weak pumpkin vine one so enormous. The philosopher in the fable complained of this irregularity of nature as he lay under an oak. But when a small acorn fell upon his head he changed his mind. Now, all this huge structure, the body of the plant, is as carefully manufactured as the delicate savory fruit, and out of the same ingredients, practically. The bulky

WATER FLOWING FROM TOP OF 39 FOOT PIPE— BARNES WELL, SAN ANTONIO, TEXAS.

part of the plant, the bone and sinew, so to speak, is the woody fiber, or lignin.

When a piece of wood is cut in small portions and cooked in water and alcohol until nothing more can be dissolved out of it there remains a white, fibrous mass to which is given the name woody fiber, or lignin. It has neither taste nor smell, and it is insoluble. Strange to say, two of its chemical constituents are the

same as water, being oxygen and hydrogen, with an equal quantity of carbon added.

Under the microscope this woody fiber appears to consist of what is called "cellular" matter, the true woody fiber, and a coating for strengthening purposes, called "incrusting" matter. This cellular matter is composed of oxygen and hydrogen in the proportions to form water, but it is difficult to separate them to determine the elementary construction, but we shall see that they demand a certain food and are intended for an important purpose.

The woody fiber sometimes constitutes a large proportion of the plant, and sometimes it is very small. In grasses and corn growing plants, it forms nearly one-half of the weight, but in roots and in plants used for food it is very small in the first stages of their growth. The following table gives the percentage of woody fiber in a few common plants while in a green state.

Name of plant.	Per cent of woody fiber.	Water.
Pea stalks	10.33	80.0
White turnips	3.0	92.0
Common beet	3.0	86.0
Red clover	7.0	79.0
White clover	4.5	81.0
Alfalfa—in flower	9.0	73.0
Rye	1.0	68.0

STARCH.

Next to woody fiber, starch is the most abundant product of vegetation. By whatever names the various kinds of starch are called: wheat starch, sago, potato starch, arrow root, tapioca, cassava, etc., they are all alike in their chemical constitution. They will keep for any length of time when dry and in a dry place, without any change. They are insoluble in cold water or alcohol, but dissolve readily in boiling water, giving a solution which becomes a jelly when cold. In a cold solution of iodine they assume a blue color.

The constituents of starch are carbon, oxygen, and hydrogen, with less carbon and more oxygen than woody fiber and about the same quantity of hydrogen.

That starch constitutes a large portion of the weight of grains and roots usually grown for food the following table will show, one hundred pounds being the quantity upon which to base the percentage:

Name of plant.	Percentage of starch.
Wheat flour	39.77
Rye flour	50.61
Barley flour	67.70
Oatmeal	70.80
Rice	84.85
Corn	77.80
Buckwheat	52.0
Pea and bean meal	43.0
Potatoes	15.0

In roots abounding in sugar, as the beet, turnip, and carrot, only two or three per centum of starch can be detected. It is found deposited among the woody fiber of certain trees, as in that of the willow, and in the inner bark of others, as the beech and the pine. This is the reason why the branch of a willow takes root and sprouts readily, and why the inner bark of certain trees are used for food in times of famine.

GUM.

Many varieties of gum occur in nature, all of them insoluble in alcohol, but become jelly in hot or cold water, and give a glutinous solution which may be used as an adhesive paste. Gum Arabic, or Senegal, is the best known. It is produced largely from the acacia, which grows in Asia, Africa, California and in the warm regions of America generally. It exudes from the twigs and stems of these trees, and forms round, transparent drops, or "tears." May of our fruit trees also produce it in smaller quantities, such as the apple, plum and cherry. It is present in the malva, or althea, and in the common marsh mallow, and exists in flax, rape, and numerous other seeds, which, treated with boiling water give mucilaginous solutions.

All the vegetable gums possess the same chemical constituents of carbon, oxygen, and hydrogen, in nearly the same proportions as woody fiber and starch.

SUGARS.

All sugars may be classified according to four prominent varieties: Cane, grape, manna and glucose.

First—Cane sugar is so called from the sweet substance obtained from sugar cane. It is also found in many trees, plants and roots. The juice of the maple tree may be boiled down into sugar, and in the Caucasus the juice of the walnut tree is extracted for the same purpose.

It is also present in the juice of the beet, turnip and carrot. Sugar beet cultivation is assuming enormous proportions in the United States, as well as in Europe. Carrot juice is boiled down into a tasteless jelly and when flavored with any fruit flavors passes for genuine fruit jelly.

It is further present in the unripe grains of corn, at the base of the flowers of many grasses and in clovers when in blossom.

Pure cane sugar, free from water, consists of the following elements, estimated in percentages:

Carbon, 44.92; oxygen, 48.97; hydrogen, 6.11; almost identical with starch.

Second—Grape sugar. This sugar is so called from a peculiar species of sugar existing in the dried grape or raisin, which has the appearance of small, round, or grape shaped grains. It gives sweetness to the gooseberry, currant, apple, pear, plum, apricot, and most other fruits. It is also the sweet substance of the chestnut, of the brewer's wort, and of all fermented liquors, and it is the sugar of honey when the latter thickens and granulates, or "sugars."

It is less soluble in water than cane sugar, and less sweet, two parts of cane sugar imparting as much sweetness as five parts of grape sugar, at which ratio forty pounds of cane sugar would equal 100 pounds of grape sugar. Its chemical constituents are, in percentages: Carbon, 40.47; oxygen, 52.94; hydrogen, 6.59. Likewise nearly the same as starch.

As a test to distinguish cane sugar from grape sugar: Heat a solution of both and put in each a little caustic potash. The cane sugar will be unchanged, while the grape sugar will be blanckened and precipitated to the bottom of the vessel.

MANNA SUGAR, ETC.

Manna sugar occurs less abundantly in the juices of certain plants than cane or grape sugar. It exudes from a species of ash tree which grows in Sicily, Italy, Syria and Arabia. It is the product and main portion of an edible lichen, or moss, very common in Asia Minor. This curious lichen is found in small, round, dark colored masses, from the size of a pea to that of a hazel nut or filbert, and is speckled with small

white spots. The wind carries it everywhere, and it takes root wherever it happens to fall. It can only be gathered early in the morning as it soon decomposes, or corrupts. The natives gather it from the ground in large quantities and make it into bread. This is said to be what constituted the "rain of manna" which fed the Israelites during their wanderings in the desert, and it derives its name from that circumstance.

Manna sugar is found in the juice of the larch tree and in the common garden celery. In the mushroom a colorless variety is found. To add two other varieties of sugar, the black sugar of liquorice root and sugar of milk may be mentioned.

GLUCOSE.

The name of this sugar means "sweet," a sweet principle, or element. It occurs in nature very abundantly, as in ripe grapes, and in honey, and it is manufactured in large quantities from starch by the action of heat and acids. It is only about one-half as sweet as cane sugar. It is sometimes called "dextrose," "grape sugar," and "starch sugar." What is known to the trade as "glucose," is the uncrystallizable residue in the manufacture of glucose proper, and it contains some dextrose, maltose, dextrine, etc. Its profusion and ease of manufacture makes it a cheap adulteration for syrups, in beers, and in all forms of cheap candies. The test for it is the same as that given to distinguish between cane and grape sugar.

All the elements in the foregoing sugars are similar in their chemical constitution, and what is still more remarkable about them, is the fact that they may be transformed one into the other, that is: Woody fiber may be changed into starch by heat, sulphuric acid, or caustic potash; the starch thus produced may be further transformed, first, into gum, and then into grape sugar by the prolonged action of dilute sulphuric acid and moderate heat. When cane sugar is digested (heated) with dilute sulphuric acid, tartaric acid (acid of grapes); and other vegetable acids, it is rapidly converted into grape sugar. When sugar occurs in the juice of any plant or fruit, in connection with an acid, it is always grape sugar, because cane sugar can not exist in combination with an acid, but is gradually transformed into grape sugar. This is the reason why fruits ferment so readily, and why, even when preserved with cane sugar, the latter is slowly changed into grape sugar and then fermentation ensues, and the preserved fruit "spoils."

GLUTEN, VEGETABLE ALBUMEN AND DIASTASE.

These substances are the nitrogenous elements in plants.

Gluten is a soft, tenacious and elastic substance, which can be drawn out into long strings. It has little color, taste, or smell, and is scarcely diminished in bulk by washing either in hot or cold water. It is a product of grain flour, left after washing dough in a fine sieve, and allowing the milky, soluble substance to pass off. The percentage of gluten in various grains is as follows:

Wheat	8 to 35 per centum.
Rye	9 to 13 per centum.
Barley	3 to 6 per centum.
Oats	2 to 5 per centum.

Dried in the air it diminishes in bulk, and hardens into a brittle, transparent yellow substances resembling corn, or glue. It is insoluble in water, but dissolves readily in vinegar, alcohol, and in solutions of caustic potash, or common soda.

Vegetable albumen, is practically the same as the white of eggs. It has neither color, taste, nor smell, is insoluble in water or alcohol, but dissolves in vinegar, and in caustic potash, and soda. When dry it is brittle and opaque. It is found in the seeds of plants in small quantities, and in grain in the following percentages:

Wheat	.75 to 1.50
Rye	2.0 to 3.75
Barley	.10 to .50
Oats	.20 to .50

It occurs largely, moreover, in the fresh juices of plants, in cabbage leaves, turnips and numerous others. When these juices are heated, the albumen coagulates and is readily separated.

Gluten and vegetable albumen are as closely related to each other as sugar and starch. They consist of the same elements united together in the same proportions, and are capable of similar mutual transformations. The following table will show the percentages in which the reader will notice that nitrogen is an element which does not exist in starch or sugar:

Carbon	54.76
Oxygen	20.06
Hydrogen	7.06
Nitrogen	18.12

When exposed to the air in a moist state both these substances decompose and emit a very disagreeble odor, giving off, among other compounds, ammonia and vinegar. Both of them exercise an important influence over the nourishing properties of the different kinds of foods, as we shall see in a subsequent chapter.

DIASTASE.

This substance may be manufactured from newly malted barley, or from any grain or tuber when germinated. It is not found in the seed, but is manufactured during the process of germination by the seed itself, or its decomposition, and it remains with the seed until the first true leaves of the plant have expanded, and then it disappears. Its functions, therefore, are to aid in the sprouting of the seed, and that accomplished, and there being no further use for it, it disappears. The reason for this is as follows:

Diastase possesses the power of converting starch into grape sugar. First, it forms out of starch a gummy substance known as dextrine, in common use as adhesive paste, and then converts it into grape sugar. Now, the starch in the seed is the food of the future germ, prepared and ready to minister to its wants whenever heat and moisture come together to awaken it into life. But starch is insoluble in water and could not, therefore, accompany the fluid sap when it begins to circulate. For which reason, nature forms diastase at the point when the germ first issues, or sprouts from its bed of food. There it transforms the starch into soluble sugar, so that the young vessels can take it up and carry it to the point of growth. When the little plant is able to provide for itself, and select its own food out of the soil and air, it becomes independent of the diastase and the latter is no longer wanted. Weaning a child will give the reader the idea.

VEGETABLE ACIDS.

There is another class of compound substances which play an important part in the development of plant foods and the perfection of growth. They are known as the vegetable acids, and it is due to them that plants possess a taste and flavor, every plant having its own peculiar acid. They are usually classified into five species and enter into combination with all of the substances heretofore referred to. They are:

Acetic acid (vinegar), tartaric acid (acid of wine), citric acid (acid of lemons), malic acid (acid of apples), and oxalic acid (acid of sorrel). Acetic acid is the most extensively diffused and the most largely produced of all the organic acids. It is formed wherever there is a natural or artificial fermentation of vegetable substances. It easily dissolves lime, magnesia, alumina, and other mineral substances, forming salts known as "acetates," which are all soluble in water, and may, therefore, be absorbed by the root pores of plants. It is an acid common in everything, and may be manufactured from wood, alcohol, cane sugar and from the juice of apples, or by any vegetable fermentation, the process of fermentation throwing off carbonic acid and forming vinegar.

Tartaric acid finds lodgment in a variety of plants. The grape and the tamarind owe their sourness to it, and it exists also in the mulberry, berries of the sumach, in the sorrels, and in the roots of the dandelion. It is deposited on the sides of wine vats, and when purified and compounded with potash, it becomes the familiar "cream of tartar," which is known to every housewife. In the grape it is converted into sugar during the ripening of the fruit.

Citric acid gives sourness to the lemon, lime, orange, grape fruit, shaddock and other members of the citrus family. It is the acid in the cranberry, and in numerous small fruits such as the huckleberry, wild cherry, currant, gooseberry, strawberry, and the fruit of the hawthorn. In combination with lime, it exists in the tubers, and with potash, it is found in the Jerusalem artichoke.

Malic acid is the chief acid in apples, peaches, plums, pears, elderberries, the fruit of the mountain ash. It is combined with citric acid in the small fruits above mentioned, and in the grape and American agave it is associated with tartaric acid. It has exactly the same chemical constitution as citric acid, and the two bear the same relation to each other as starch, gum and sugar. They undergo numerous transformations in the interior of plants, and are the cause of the various flavors possessed by fruits and vegetables.

Oxalic acid has poisonous qualities, but an agreeable taste. It occurs in combination with potash in the sorrels, in garden rhubarb, and in the juices of many lichens, or mosses. Those mosses which cover the sides of rocks and the trunks of trees sometimes contain half their weight of this acid in combination with lime.

This chapter is, of course, one step farther in advance of the one immediately preceding, and the facts stated are intended to lead on up to a complete, practical knowledge of the forces of nature operating in the soil and within the plant to attain perfection. Nothing but the bare essentials, the mere outlines, have been given so far; to attempt to enter into all the details would be to write an entire volume, the reading of which might prove tiresome and unproductive of anything practical. All that it is desired to do in these preliminary chapters is to furnish the reader with sufficient elementary knowledge to enable him to go farther on his own account and to infer what the soil needs for the cultivation of plants; how that soil is to be cultivated, and how the element of water is to be applied to it in order to increase its productiveness and his profit. This is the true preliminary to irrigation, as we imagine, for it would convey no information to suggest the pouring of water on the soil, and drenching plants and crops with it, unless the intelligence is prepared to understand why that should be done, and all the details and consequences laid before the reason and common sense.

So far, the reader ought to have a comparatively clear idea of the chemical constitutions of the substances which enter into the soil, and from the soil into the plants, but there still remains the question: How do the substances necessary to plant life get into the condition of plant food? This question will be answered in the next chapter.

STATE PROGRESS—WYOMING.

CLARENCE T. JOHNSTON, STATE ENGINEER.

Read before 11th National Irrigation Congress, Ogden.

The irrigation law of Wyoming, practically as it stands today, was passed by the first State Legislature in the winter of 1890-91. Under its provisions a State Engineer and four division superintendents have supervision of the waters of the State. The five constitute a Board of Control which has quasi-judicial functions in the settlement of rights to use water. Each division is divided into districts and local supervision is exercised by a water commissioner. The object of the law was to prevent controversy over water, and the experience of the last thirteen years shows that it has not been a failure in this respect.

The State Engineer is, under the law, required to keep informed as to the water supply of the streams of the State, and water can not be diverted without first obtaining his consent. His decisions are appealable to the Board of Control, and from that body to the courts. When a stream becomes fully appropriated during the irrigation season further permits to divert water are refused and the proposing irrigators are advised to construct reservoirs and store the flood waters. When these become exhausted, all further diversions are prohibited. So successful has this supervision been that no decision of the State Engineer on questions of water supply has been appealed.

Where conflicts have arisen on streams over the division of water the Board of Control has adjudicated the claims. The doctrine of priority of right has here been carried fully into effect, and 5,000 certificates of appropriation have been issued under the decrees which have been rendered. The decrees issued by the Board of Control can be appealed to the courts, but only five appeals have been taken, and two of these are now before the Supreme Court. The Board has been sustained in every case where a decision has been rendered by the court. Appeals are becoming even less common than they were during the first few years after the law went into operation. After an adjudication has been completed and the decree of the Board carried into effect, peace reigns and it is but seldom that a water commissioner is called upon to distribute the water to those who are entitled to it. Under the

law the water does not belong to the dich or to the irrigator but to the lands upon which the water has been applied, and in an amount not exceeding one cubic foot per second for each seventy acres irrigated. The sale of irrigated lands, therefore, carries with it a title to the water necessary for its cultivation.

During the past year 1,500 applications have been received in the State Engineer's office for ditches and reservoirs. Nearly 1,000 notices have, in the same time, been received of the completion of such works. The application is not a water right but rather a description of what the applicant proposes to do, and when such papers are approved they are only the written consent of the officer authorized to act for the State to the proposed diversion of water. If the stipulations set forth in the application are not complied with, the application is cancelled and another party is given an opportunity to make use of the water. When works are completed they are inspected by the Division Superintendent, and if all requirements are complied with the Board of Control issues a certificate of appropriation, setting aside a certain volume of water for the irrigation of lands described in the application.

The cost of the state irrigation administration has averaged about $10,000 per year. Of this less than half has gone to the Board of Control. It has cost the State, therefore, less than $12.00 for each final certificate of appropriation that has been issued. The claimants to water are required to pay $1.00 for each Certificate of Appropriation, and seventy-five cents for having the same recorded in the offices of the county clerks. When these figures are compared with the cost of litigation in some other states it will be seen that the Wyoming irrigation laws bring about a great saving to the Commonwealth as well as to the individual water user.

I believe that the laws of Wyoming are adapted to protect the irrigator under any kind of a meritorious enterprise, and whether the work be done through the State under the Carey Act, by private individuals alone or by the National Government under existing laws.

Wyoming invites the Federal Government to proceed as fast as possible in the construction of irrigation works, believing that the provisions of the national law will be supplemented by the laws of the State, and that better protection will be given the settler than is usually afforded. It will be found, upon examination, that the expenditure on the part of the Government will never compare with that of individuals in the reclamation of the West. Individuals must be protected from diversions of water by the Government as must the Government projects be protected from diversions by individuals. Under existing conditions the Government could not prevent water being diverted from streams while its projects were under construction unless a close co-operation with state irrigation authorities be secured.

I should like to impress the delegates present that there is no reason for fearing a conflict between State and National laws in the construction of irrigation works by the Government. After the Government has completed the works and sold the lands, it must devolve upon the State to protect the people who use the water from such diversions from the stream as would threaten their rights. Let us not, therefore, permit ourselves to believe that the states and the Government have anything but a common interest in seeing the irrigation law carried out so as to do the most good to the greatest number.

BARLEY BY IRRIGATION.

HENRY ALTENBRAND, PRESIDENT MANHATTAN MALTING CO., MANHATTAN, MONT.

Delivered before 11th National Irrigation Congress.

I am to speak on barley raised by irrigation.

Barley, now one of America's standard crops, has long been raised with varying success in many of the western states, and the growing demand which now exists for malting barley has opened up a large field for the extensive cultivation of this crop by the farmers of our northwestern states.

HENRY ALTENBRAND.
Pres. Manhattan Malting Co.,
Manhatten, Montana.

Now, it will be in order for me to give you the information as to how barley is actually consumed by the beer-brewing industry, whiskey, and barley malt food and cereal products.

There are consumed by the brewing industry 60,000,000 bushels; between 5,000,000 and 6,000,000 bushels in the manufacture of whiskey, and 1,000,000 bushels in the manufacture of cereal foods, making a total of about 67,000,000 bushels of barley in the United States, this date.

The beer consumption has been on the increase steadily for the last ten years, and this last year it amounted to 3,600,000 barrels, and the total amount which the beer industry pays to our government alone is $46,000,000 tax on 46,000,000 barrels.

Previous to the year 1880, a very large proportion of barley used in the manufacture of malt in the United States, for beer, was imported from Canada, Canada having the name of producing the best barley, there being, at that time, about 13,000,000 bushels imported to America, subject to a duty of ten cents per bushel.

In the year 1887, a duty of thirty cents was put on the Canadian barley, and by that means increased the cultivation of barley in the United States; and in the year 1889, I imported from Germany 2,000 bushels of German Saale barley, this barley having the reputation of being the finest in Germany and was largely used in England. This seed I introduced into five states: Minnesota, Wisconsin, Iowa, New York and then in the Gallatin valley, Montana, by irrigation.

The idea of distributing this barley in the various states was to determine whether the climate of these various states was adapted to the successful raising of this barley.

Samples of the barley were taken the first year from crops grown in each of the above-mentioned states, which were given to farmers who were experienced in the cultivation of barley, and in the instance of the first five, it was found that it had degenerated both in qaulity and appearance from the mother seed. But in regard to the crop grown in the Gallatin valley, on the Manhattan Farms, in Montana, under irriga-

tion, it was shown that same was a wonderful improvement, being fuller, heavier in weight, and wonderfully bright in color.

The impetus thus given to the raising of barley by irrigation in the Gallatin valley has been continued with ever-increasing success, year by year, until today, the Gallatin valley, Montana, is famous the world over as a great barley-raising section. I will state that the long sunshine and cool nights that we have in the Gallatin valley helps to fill the grain, irrigation giving the necessary moisture to the grain when most needed, and finally, the absence of any rainfall during the harvest time, which insures the bright color so much desired. Not alone do we improve the quality of our grain by irrigation, but also increase the yield, in many cases double that raised without irrigation.

Montana's rainfall, annually, is about eighteen inches, occurring during the winter, spring, and fall months, affording ample moisture for the germination of the seed and growth of the grain in early stages; the happy combination of cool nights and heat of perfect summer days, and the artificial moisture by irrigation, gives a growth and development to crops, unknown to any region save that of the mountain states, which the situation, climate conditions, and soil, make the ideal barley land of the world.

This may seem to some rather a sweeping statement, but I assure you the results already known throughout the malting and brewing trade of the world fully back up what I say. Both oats, wheat and alfalfa have the same results in this valley.

Unlike the farmers of the Mississippi valley, the farmer farming with the aid of irrigation, sows his crops with the confident assurance of reaping the rich reward of his labors, based on the unbroken record of no crop failures.

This immunity from crop failures rests upon the unfailing bounteous supply of water for irrigation, coming as it does from the hundreds of mountain streams flowing from perpetual snow drifts, which, yielding to the rays of the midsummer sun, afford the moisture to the parched fields during the period when the grain is filling and the crop is most in need of it.

The soil—the ideal soil for barley raising—is here found in Montana, particularly in the Gallatin valley, where is found the rich alluvial soil of a rich nature and light chocolate in color. Added to this comes the irrigation, which is both meat and drink to the soil.

The water, finding its way from the mountains, through timber girt ravines and coullees, bears in solution vast amounts of detritus, rich in organic matter; this applied to lands already doubly rich in potash, phosphoric acid and nitrogen, give them year by year the ability to produce crops that are the wonder of the world.

In the year 1893 at the World's Fair, Germany sent over to this country, six commissioners, connected with the Agricultural Department of Germany, one to look into the question and investigate the cultivation of the sugar beet and as to its sugar quality; another as to wheat, and its flour industry; another as to flax and its flax oil industry; another to hops; and another to barley as to the barley industry, and further to investigate the question of industries in our country and its advantages. They traveled and investigated industries from California to the Mississippi, and spent one week on the Manhattan farms, in the Gallatin valley, Montana, and they were surprised in seeing that the German Saale barley was produced finer by the mother seed, by irrigation. On the return of this commission to Germany, their report was rendered to their governments and reports were made by these respective commissioners to their respective industries, giving their full report as to how they found things in America. The one special report made by Prof. Dr. Delbruck, who was then, and is today, the chief commissioner of agriculture to the German government, was of particular interest to all connected with malting and brewing interests of the world, coming as it did from one, conceded by all, to be the highest authority on this subject.

I will take the liberty to read you a portion of that report. He writes, that

"Here in the Gallatin valley, Montana, on the Manhattan farm, I found a country and a system of cultivation ideal for the growing of barley; in fact, here I have seen the barley—the German Saale barley—raised, the finest barley that I have ever seen; bright in color, large size, fine as to husk, equal to the very best of our European barleys, and decidedly the superior of anything raised in North America. Here in harvest times, barley damaged and discolored by rain is unknown, because they have no rain. Withered or dried-up barley is equally unknown because they have here irrigation, by which the grain is given the necessary moisture at the time it is most needed."

As a further proof that we have in Montana the ideal barley-growing lands, with the aid of irrigation I would say that the last spring I took from Canada, Minnesota and Wisconsin, the six-rowed barley which is raised so extensively therein, and I planted the same in Montana, where with irrigation, the grain that in Canada, Minnesota and Wisconsin, under the most favorable condition, is harvested with thirty-six to forty kernels to the head, we harvested in Montana, raised under irrigation, with eighty to ninety kernels to the head. And I have here in my hands to show the heads raised by irrigation, which is six inches long, against those that are raised in Wisconsin and Minnesota, in the natural state of cultivation, only from three to four inches long. Now we have eighty to ninety kernels to the head, as stated, which are much larger and better developed and brighter in color, as against those grown without irrigation in those respective states. Only another instance where irrigation succeeds in the way of raising cereals. I will state here that other favorable results are obtained in our raising of oats and wheat.

I have always felt ever since I have looked into this irrigation question, which is now nearly fourteen years, that it is a great blessing wherever it can be applied, and I felt it was my duty to give all the aid I could in helping this good cause and the very good work, irrigation, for which the congress is here assembled. I am a great believer in this irrigation. It may not be in our life time that we will see these great results and the time will come when our children and relatives may say that our fathers, brothers and, uncles have helped to lay the foundation for this great cause, and it brings back to me a recollection of what Prof. Dr. Delbrück, of Germany, said to me when we parted. He said "that if this country succeeds in making use of this great blessing in using their water ways to irrigate this

great country we will then be able to raise all the cereals required in the world."

Thus from the recorded statement of the highest authority in Europe, goes to prove, beyond doubt, that this great western country of ours, these millions of acres, will, with the aid of irrigation (which is nothing short of a blessing) and with the aid and means that we are now giving and asking our government assistance to this noble work, will be the means of making this country one of the greatest and richest and most flourishing countries of the world.

CORRESPONDENCE.

Hood River, Ore., Oct. 30, 1903.

Editor Irrigation Age:

Dear Sir—Will you kindly inform me of the name and address of firm making tools for irrigation purposes, who make an implement that can be pulled by a horse, that will make a rill similar in size and shape to the Planet, Jr., garden plow, arranged so as to make the furrow on the same side of each row, to throw all the soil way preferable. Yours truly, E. H. Shepard.

Eagle Pass., Tex., Oct. 12, 1903.

The D. H. Anderson Publishing Co.:

Gentlemen—In your Irrigation Age there used to be advertisements of levels for laterals, suitable for aiding in the selection of dam sites, or any short line, at reasonable price. I need one now. Several people of late have asked me about such an instrument. Can you kindly tell me where to get such an instrument and oblige. Yours truly,

P. W. Thomson.

Denver, Colo, Oct. 25, 1903.
1655 Downing Avenue.

Mr. D. H. Anderson, The Irrigation Age:

My Dear Sir—Yours of the 10th ult. met me on my return from a three weeks' absence on a state road survey in the mountains. The September Age also to hand. Wonder the postoffice authorities keep up with me, even sometimes, with as many changes of address as I have had in the last five years. In some ways I am perhaps "a well known citizen." I shall mail this at Castle Rock, Colo., today, whither I go on professional errands, and to attend meeting called by supervisor of forests for farmers, miners, cattlemen and millmen. Please address as above "till forbid." I am with Prof. Carpenter in state engineer's office. Very truly thine,

John S. Titcomb.

London, Ohio, Oct. 18, 1903.

D. H. Anderson, Editor Irrigation Age:

Dear Sir—After respects, etc., permit me to ask you to turn to page 326, September number of The Age, under your editorial heading, "Merging, Fusing and Amalgamation," and read the third sentence beginning with "But" and ending with "the wall" (go no further in thought or otherwise) and you will read the death knell of the Drainage Journal. The surgeons at the operating table were Messrs. C. G. Elliott, C. E. and D. H. Anderson, editor Irrigation Age. Leaving out, as not applicable herein, the latter part of the third sentence, never did I read an editorial that so fully describes the cause of a thing giving unimpeachable reasons therefor. But there are no grounds for blaming either party for the demise of the Drainage Journal.

In some of their bearings The Age and Journal are identical. They both deal with water. They both must have canals, ditches and laterals. But the use made of the water by the two systems differ diametrically. Irrigation wants to carry water into the soil. Drainage wants to carry the superabundant water out of the soil. The Primer of Irrigation will show how drainage water is used for irrigation. Barren, arid land will not produce without irrigation; neither will flooded land produce without drainage.

The perusal from time to time of The Age shows that its editor is a pioneer and at home in his field. But where, O where, is the champion for drainage?

I have just received a letter from a party in Iowa, who wrote me after reading squib in the September number of The Age inquiring if I knew of any publication devoted to drainage. In all friendship, yours, etc. J. Arnett.

We have answered this letter editorially and the reader is referred to that answer, which is believed to be satisfactory.—Editor Irrigation Age.

SILAS THORNAPPLE'S OPINIONS.

ON GITTIN' A HOME.

"Deacon Turnbull is tryin' to argufy with them ez hain't got none, to git a home by all means, an—"

"An' at all hazards," says Sam Durkee, who had been preached to by the Deacon on several occasions, "leastways, thet's the way it 'pears to me sence the Deacon hez the homes to dispose uv."

"What is a home?" inquired Zeke Pennywhacker, who sot by the cracker barrel, utilizin' his opportunities. "Is it suthin' you can git ready made like them all wool skeeter net wove suits at the department stores? Is it suthin' like the turkey hash you git at the fifteen-cent eatin' emporiums pervided you hev the fifteen cents?"

"I ruther guess not," says I. "When anybody says to me: 'Silas, git a home,' I allus recall what the sick feller said to his doctor when he wuz sufferin' from loss uv appetite. Says the doctor to him: 'You must go out every mornin' bright an' early an' take a walk on an empty stummick.' 'I'll do it cheerfully,' says the patient, 'ef you'll pervide the stummick fur me to walk on.' An' so, when a feller says to me: 'Git a home,' I ask in puffeck good faith: 'Whose home shell I git?' No, sirre, thar ain't no homes flyin' around hopin' to git took."

"I dunno about thet," says Ezra Gregg, "thar's Ozone George who is a promisin' homes to fifty million families in the great arid pastures of the West, whar land is wuth twenty-five cents an acre an' water six bits a quart. Whar the air is so pure an' dry that you don't need a refrigerator to keep meat from spoilin', and whar thar is potash enough in the back yard to make a car load uv soap. Whar the cuckoo sings hot two steps an' the hens lay hard boiled eggs. Whar—"

"You durn fool," says I, impatient like, fur I wuz riled, "hev you gone an' paid in a subscription to the good cause?"

Ezra hung his head ez if shamed an' said no more. His confusion bein' evidence uv his guilt, I needed nuthin' further to explain why he hed recently put a mortgage on his ranch. So shakin' my head mournfully I remarked: 'What is home without a m-m-m—?"

"Mother," added Zeke Pennywhacker, thinkin' I hed forgot the word.

"No, mortgage," said I, laffin' fit to kill, at which good humor wuz once more restored.

"Thar wuz oncet a time," perceded I, in a reflective tone uv voice, "when a man could git a home whenever he wanted one without desirin' the improvements which are now considered ez the necessary attributs uv any sort of a home. He took his axe an' goin' into the woods hewed one out uv of the forest.

"It is true thar wuz bar an' Injuns which occasionally skulped him, but they left him the greater portion uv his hide fur his own use an' behoof. He killed the bars and convarted their hides into clothes, an' he bamboozled the Injuns out uv numerous extras in the way uv home comforts at the expense uv a few glass beads, sheet iron tomahawks, an' all wool cotton blankets, the runnin' colors uv which durin' the fust rain transformed the surface uv the noble red man into the stars an' stripes. The home maker wuz free ez air an' he asked no man fur odds.

"Now whar are we? Whar are the homes we are advised to git so strenuously? Kin we go an' take them by the hand an' say: 'Welcome, home, let me drive my stakes down into your sile an' call you my own without let or hindrance?' Does any home now offered us with so much flourishin' uv trumpet, an' so much sheddin' uv printer's ink, take us by the hand an' say: 'Welcome, brother, come in an' help yourself?' Nary. The bars are on hand an' the Injuns survive, but we don't do any more skinnin', on the contrary, we are the skun. It are the Injuns ez are a bamboozlin' us, an' they are a-doin' it with so remarkable a cheapness to themselves an' with so much costliness to us thet by the time we git a home we are obleeged to move out uv it and hunt fur another somewhere else under the same onerous conditions. In my humble opinion, founded on fac's the genuine home seeker hez gone entirely out uv business.

"Look the indublicatable fac's in the face, feller citizens" says I, waxin' warm with the subjec', the thorts rushin' through my brain in riotous profusion ez I proceeded. "What's the fust thing thet hez to be did to git a home? A contribution. Fur why should I pay you a contribution?" I asked Ozone George, when he intermated thet thar wuz one a-comin' to him.

"Why, fur pertection," says he.

"Pertection against what?" says I.

"Pertection against the fellers ez are a-stealin' all the land, so's when you git a home they won't steal it out from under ye."

"Good and great idee," says I, "but unfortnitly, I hain't got any home roamin' around waitin' to git stole."

"Mebbe you hain't now," says he, "but thar are others ez hev homes; they want to keep from the clutches uv the villains, an' it is your duty ez an honest man an' a patriotic American citizen to help your fellow men."

"Thet's the real missionary spirit," says I. "It's like takin' up a collection fur the far away heathen. Will you kindly remove your hat, George?"

"What fur?" says he.

"Why," says I, "whenever anybody wants me to contribute for the relief uv the heathen, or to help the poor an' sufferin' of the kentry, I allus like to be sure thet his halo is on straight."

But George turned away without sayin' a word, an' without removin' his hat, so I am obleeged to yield to my suspicions thet all is not ez it should be, an' thet the homes George is offerin' to the unborn millions are tied to a rubber string which jumps the home back out uv reach when you make a grab fur it.

At this pint in the perceedin's, Lawyer Goodwin came in an' wanted to know what subjec' we hed been discussin'. After readin' the minutes uv the meetin' ez fur as we hed got, he run his fingers through his shaggy mane, an' says:

"Silas, you are wrong, an' you are a-misleadin' these innocent an' confidin' folks."

"Ez to how?" I demanded, bridlin' up, fur I won't bear contradictin' when I know I'm right an' everybody else wrong.

"Why, don't you see," says Lawyer Goodwin, "thar's seventy-four million acres uv rich sile in the western half uv the United States capable uv supportin' fifty millions uv people, but thet land needs water wuss'n a duck durin' a prolonged drought. It is not in harmony with the spirit uv the age to keep this vast desert a-goin' on any longer without bein' reclaimed.

"I tell you, feller citizens," an' the lawyer squared himself off ez he does when addressin' a jury, "land without population is a wilderness, an' population without land is a mob. In view uv the enormous number uv implements an' vehicles thet would be required to supply this vast—this vast—this vast—" here the lawyer began fumblin' in his pocket for papers or suthin' else to refresh his memory, which appeared to hev suddenly deserted him. He didn't find what he wuz seekin', so I took up his line uv argument:

"This vast section uv kentry, when put under cultivation by a proper system uv irrigation, built an' controlled by the general government, the influence an'—"

"Look here, Silas, thet's my letter you're a-readin' from," an' the lawyer made a grab fur it. but didn't git it.

"Tain't yours, neither," says I. "It's one I got from Ozone George regularly through the rural delivery, laid down at my very door, postage paid."

"Silas," says he, drawing me to one side, "are you onto this game?"

"Uv course," says I, "ain't you?"

The lawyer winked suggestively which cast a flood uv light into my intellect, but I couldn't git him to tell me the size uv his retainer.

"It's gittin' so these days, Silas," explained Lawyer Goodwin, "thet it is extremely difficult to tell which side a man's on in any subject. In view uv the enormity uv the things thet hev been suggested by Ozone George in this reclamation campaign, it is jest ez well fur a man to be on all sides uv it, fur thar is allus some fat pickin's to be hed. Thar's the implement men an' the growin' fund, an' thar's them ez want to git some uv of thet fund. Then again, thar's the bloomin' homeseekers, homesickers, they should be called, an' it may be thet sometime they will git on top. Ef we can't straddle the blind, Silas, why shouldn't we skin the pot?"

"Thet puts a diff'rent complexion on the whole matter," says I, "ef thar's any wav fur me—you know —jest give me a pinter when the time comes."

"I onderstand, Silas, a hint is ez good ez a kick to a blind hoss. I will see Ozone and tell him you have experienced a change uv heart."

"It's got to be did quick, lawyer," says I, "thar's thet gosh blamed note you hold."

"I'll turn thet in on account, Silas."

I went home happier thet night than I hed been fur six months, fur I felt thar wuz suthin' a-doin'. My opinion is that reclamation is a good thing fur the kentry.

COLONIZATION GROWING.

The following facts indicate the growth of colonization in two localities by the subdivision of large tracts of irrigated land:

On the Laguna de Tache grant previous to July, 1902, there were only two Dunker families; up to August 1st, 1903, there have moved in 55 families, consisting of 129 people, with 11 carloads of household goods. They bought 690 acres. During the same period 251 prospective settlers appeared to make arrangements for homes.

In the South Platte valley in Colorado, 17 families bought 3,160 acres in 1902. In 1903 39 families, consisting of 91 people, bought 9,275 acres, and brought in 20 carloads of household goods. Twenty-nine prospective settlers also made their appearance.

An Overlooked Editorial.

It is a source of gratification to THE AGE that the good seed it has been planting has begun to sprout and shows every indication of becoming a healthy plant.

We have had some opinions concerning the manner in which the objects of the National Irrigation Act of Congress has been wrested from its purpose, and we have not hesitated to point out the rascalities in course of incubation to destroy the homestead laws for the purpose of enabling land syndicates, combines, and corporations to be the sole dispensers of private lands at high prices.

Again, THE AGE has not hesitated to show the malign influences working behind the State legislatures to place the home seekers of this country at the mercy of grasping private land owners. From all these its constant litany has been: "Good Lord deliver us."

We know, as does everybody else who is not subsidized to say the contrary, that these malign, or let us call them "malignant" influences, enjoy the estimable privilege of owning the bodies and whatever is visible of the souls of certain organs that are played upon from time to time, and groan out a monotonous tune similar to "The Old Cow Crossed the Road," in sixteen verses, all of them being similar to the first, but oft repeated appear different to the unmusical ear.

One of these "organs" which would be as big as the planet Jupiter were its skin not that of a microbe, incapable of expanding to any greater size than a pin head, is the *Riverside Daily Press*. This great daily submits two printers' sticks of advertising space to compliment the IRRIGATION AGE upon its ignorance of the California Works Bill and nobly earns its subsidy by ridiculing the idea of anybody trying to get the irrigators of California in his power.

THE AGE would not lament this charge of ignorance on the part of the talented and distinguished scientist, statesman, and bottle holder of the corrupt, grasping gang that hires it to play the jester, but, it feels the sting of it, when the *Citrograph*, for a small dribbling stipend accepts the mouthings of the Riverside organ and adds some alleged wit which is not worth the space given it. This little unripe, sour citrus says "WE were there," and that there was nothing wrong at the Riverside convention. Surely not, for the WE filled the entire convention hall, though some say it could not be found with a powerful microscope.

The only complaint THE AGE has to make concerning these thin smoke ups is, that the *Citrograph* needs a few lessons in Latin elements before it can make its misquotation influential, and that it winds up by saying: "Mr. Maxwell can take care of himself." Both the *Press* and the *Citrograph* may have such confidential relations with Monsieur Maxwell as to justify them in their statement, but the greater part of the community have been under the impression all along that Monsieur Maxwell was unable to take care of himself without the valuable assistance of the *Press* and the *Citrograph*.

We beg to thank the two great journals for even noticing THE AGE by attempted witticisms.

MR. J. A. CHARTAR, M. E.
In Charge of Gas and Gasoline Engine and Irrigation Dept., Fairbanks Morse & Co., Chicago.

Pocatello, Idaho.

Pocatello, Idaho, has the advantage of a location which few cities possess, and promises to become a center from which an incalculable quantity of power and energy can be distributed easily and cheaply.

The Pocatello Power, Light & Water Company (The J. H. Brady Company) have nearly completed a pole line reaching out to Blackfoot a distance of twenty-five miles. The power plant of the company utilizes the Snake river at American Falls and the power is used for pumping water, lighting and other purposes.

Within reach are the famous Shoshone Falls, the grandeur of which beggars description. The accommodations for visitors are excellent and reasonable, and the region about Pocatello bids fair to become a favorite place of resort. Blue Lakes, Twin Falls and the Shoshone are nature's wonders not to be missed.

EL PASO, TEXAS, AND VICINITY.

The city is beautifully situated on hills on the banks of the Rio Grande river, and the site is everything that could be desired for a great city. She lies at an altitude of 3,500 feet above sea level, with beautiful mountain scenery on all sides, excellent drainage, and magnificent sites for residence and business buildings. By looking at the map one may see that El Paso is located in the southwestern corner of the state. The Rio Grande river and Chihuahua, Mexico, constitute its southern boundary, its latitude being about that of Savannah, Ga., and San Diego, Cal.

The county of El Paso, in which the city is situated, has a frontage on the Rio Grande river of about 147 miles, with a superficial area of about 7,000 square miles or 4,480,000 acres. This county, it will be readily be seen, is twice as large as Delaware, as large as Connecticut, and six times as large as Rhode Island. Its surface is diversified with mountains, valleys and plains. Sufficient of each to give variety to the grasses, soil and climate and picturesqueness to the scenery.

That portion lying along the river and constituting the valley proper is an alluvial deposit of as rich and productive soil as can anywhere be found. It varies in width from one to six miles and while in many places there is a heavy growth of timber, there is everywhere sufficient for all purposes of the farm and home. The valley is said to have been settled by the Jesuits in 1620, since which time portions of it have been under successful cultivation. The climate is dry, healthy and delightful. The rainfall averaging from ten to fourteen inches and the thermometer rarely indicating above 100 degrees in summer, while the winters are mild, the mercury rarely falling below twenty above zero. The ground is never frozen and the snowfall under all circumstances is extremely light, never remaining long upon the warm, unfrozen ground.

The productiveness of the valley of the Rio Grande, especially in the vicinity of El Paso, is unsurpassed in any locality. Nearly all of the products of the temperate zone may be produced here in abundance and perfection. The cereals, wheat, corn, oats, barley, rye, etc., yield as much per acre and of as good quality as in any part of the United States. The grasses, alfalfa, millett, timothy, Bermuda and all others which have been thus far introduced, do well. Alfalfa does remarkably well and may be cut from four to five times each season, averaging from six to ten tons per acre. It is also a perennial, with a vigorous growth of root, often penetrating twelve to fourteen feet below the surface. Vegetables of nearly every known variety and especially all those that are grown on vines, do as well here in all respects as anywhere in the United States. The soil and climate are perfectly adapted to the growth of apples, pears, peaches, plums, grapes, quinces, apricots, nectarines, almonds, prunes, strawberries, raspberries and numerous others. All of these have been thoroughly tested, as the numerous orchards in the valley now testify.

A MARCHING SONG.

When life looks blue as the deuce to you
And your step grows feeble and slow;
When your shoulders droop with a weary stoop,
As if bowed with a weight of woe,
When fame seems farther than ever away
And fortune is only a jilt,
Just think of a song as you go along
And march to a lively lilt.

With a hep! hep! as you onward step,
Now mark the effect on you;
You'll quickly see what a change 'twill be,
When the world looks kind of blue;
For courage will spring in your heart again
And sorrow will leave you soon.
If you forward step with a hep! hep!
To the time of a marching tune!

When grief and gloom in your heart have room
And you're tired of babble and talk,
Go forth, I say, in the light of day,
For the balm of a lonely walk;
The spirit that sits on your heart may be
With many another allied,
But they won't stay long for the ring of a song
And the swing of a marching stride!

With a hep! hep! as you onward step,
Oh, this is a sovereign cure
For minds that mope in the dark, and grope
In the mist of a mood obscure;
Oh, doubt and fear from your heart will fly
And joy will replace them soon
If you onward step with a hep! hep!
To the time of a marching tune!

—*Denis A. McCarthy.*

If the scientists keep on every farmer will be compelled to establish a drug store on his ranch. If a horse or cow gets enough hay and carrots what does either care whether they are called protein and carbohydrates? And if the farmer has enough to keep them in good condition what does he care?

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THE IRRIGATION AGE

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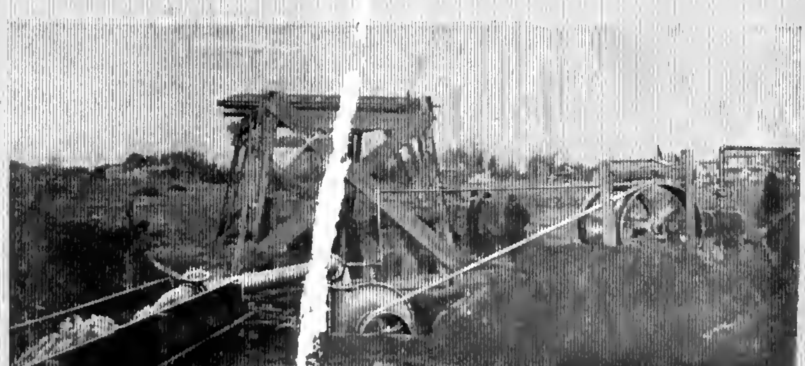

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THE IRRIGATION AGE

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

Cause For Our Delay. The delay in issuing our December number was caused by storms delaying matter for a special El Paso and Payette edition. El Paso matter is not yet all in, but will be made a special feature of a hundred-page New Year's edition to appear early in January.

From Our Christmas Tree. There is no reason why the unsentimental delvers in the soil, ditch diggers, and tile layers, are not entitled to the good wishes extended to all during the Christmas and New Year's season.

Accept the hearty greetings of THE IRRIGATION AGE, peace to all you men of good will. May your ditches run full, and your crops shadow the earth. May your drainage tile carry off the alkali that curses your soil. May you never know what it is to have a drought, and may evaporation, run off, and seepage keep far from you.

May you enjoy the luscious fruits of your own labor beneath your own vine and fig tree, and may the tax collector be easy with you, and all land reformers, schemes, pious amendment-to-the-land-laws dope fiends keep beyond range of your shotgun. May you grow fat, contented and happy, and in the near future find blissful, toilless repose, with a substantial bank account to lean upon.

Good Gracious! THE IRRIGATION AGE is reliably informed that one Mr. George H. Maxwell is boasting that, by reason of his strong pull with the transcontinental railways, he will see to it that the several companies will place no more advertising in its columns. As our bucolic friend, Silas Thornapple, would say: "This is puffickly orful!"

Inasmuch as THE IRRIGATION AGE has never obtained anything from the railway companies which it has not paid full value for, either in cash or in advertisements, the publisher does not consider that he is under any obligations to them for "favors." Perhaps it is a fancy, but we wish we could say the same of Mr. Maxwell. It might be to the advantage of his credibility, good faith and influence in the curious schemes he appears to be fostering.

By the way, if George's boast is founded upon fact, it puts the transcontinental railways in the position of verifying what we have always insisted upon, that Maxwell possesses some mysterious "pull" which compels them to follow his lead like a flock of sheep following a bellwether down a precipice. We can imagine what that pull is, but would like to have George give us the details for future use when we ask a "favor" of the railroads.

THE IRRIGATION AGE of Chicago, and Modern Irrigation of Denver, will be issued every month as usual, even if Mr. Maxwell should procure a writ of injunction against their publisher traveling on any railroad in the United States.

Pumping for Irrigation. We are presenting in this issue the first installment of Bulletin No. 45, issued by the New Mexico College of Agriculture and Mechanic Arts, on "Pumping for Irrigation from Wells." This bulletin was prepared by Professor John J. Vernon and Francis E. Lester, and treats a subject of vast importance to all interested in agricultural pursuits in valleys where a well defined underflow is found. This bulletin will be reproduced in full in the columns of The Irrigation Age during the six months to come, and will be finely illustrated by photographs taken during the different stages of the work.

Proceedings Eleventh Congress. No one, so far as The Irrigation Age has been able to learn, has seen a copy or any parts of the proceedings of the Eleventh National Irrigation Congress held at Ogden, Utah, September 15-18 of this year. Is it possible that the gentlemen having the matter in charge will let the work drag along as it has in previous years, so that it will not reach the public until it is so old that the information contained therein is valueless? The gentlemen of Ogden having this matter in charge should know from past experience that a report of the proceedings issued but a month or two before the Twelfth Congress will make them practically useless except as historical records.

Perplexing Attitude. George H. Maxwell took on a strange attitude when he worked so strenuously to forward the repeal resolution movement at the Ogden Congress. He failed, as he should have, of course; but neither success nor failure could have explained to the delegates who know his history, and particularly those who listened to his harangue at Colorado Springs in 1902, how a man who puts himself on record before a body of nearly 500 intelligent gentlemen who were delegates to the Tenth Congress, as of the positive opinion that the Irrigation Congress had no excuse for living or continuing as an active force after the National Irrigation Law was passed.

This "took on," we say, "a strange look" when he worked so vigorously on his repeal resolution in a body which the year before he had classed as "renegades and dead ones." This sudden activity on Maxwell's part was not easily explained to those who were acquainted with the inside facts, and it is the opinion of the Age that had his actions at Colorado Springs been proclaimed before the delegates at Ogden he would not have been allowed to speak at all. Maxwell's days as a self-appointed boss are numbered, but he dies hard, as evidenced by the manner in which he is "working" the commercial clubs through those states where no legislative session will be held this year.

Be Wary, Gentlemen. In conversation recently with the publisher of a prominent daily newspaper, who has spent the past month in Washington, it was learned that a feeling approaching panic has come over those who have watched the first work of the Reclamation service since funds have become available. Our informant stated that a leading senator had stated to him that the handling or preparation for disbursement of the immense fund set aside by the law is, in a mild sense, appalling. To illustrate the condition, it was stated that the money is being apportioned for various projects with the abandon of a schoolboy on a holiday. One story tells how the modest sum of $2,000,000 is inserted in one, or a combination estimate as "incidentals."

How about this, gentlemen of the Geological Survey and Hydrographic division? Is there any foundation of truth in these stories, or are they merely vaporings of disgruntled aspirants to your official positions? The public has its eye on you, gentlemen, so be wary—be wary.

A Disciple. Mr. Newell is a disciple of Mr. Maxwell's in matters relating to the land laws. In fact, Mr. Newell shares the fears of Senator Gibson that fraud is very common under the provisions of these laws, and while he is under the Interior Department he admits that the laws should be repealed. He does not believe that they can be enforced, but he believes he can carry out the provisions of a new law under which great irrigation works are to be built, knowing that he does not have the training or experience that would secure him even a moderate position in the same kind of work outside of government service. Mr. Newell does not seem to have any confidence in the ability of the present Commissioner of the General Land Office. The Age must again differ with the "Chief Engineer" of the reclamation service. Mr. Richards has been connected with the government at various times for the past thirty years, either as a surveyor of public lands, a United States Surveyor General, or an officer of the General Land Office. He has come up from the ranks and understands the practical side of his work, and no other Commissioner of the General Land Office has been so thoroughly qualified.

Reports came from Washington during October that Mr. Richards would recommend the repeal of the land laws that are objectionable to Senator Gibson, Mr. Maxwell and Mr. Newell. His report has since been made public, and what does he recommend? He does not deny that there has been some fraud under the operation of these laws, but like a capable and courageous man, he asks for more assistance in order that claims may be inspected and thus prohibit title passing until the law has been strictly complied with. We are not in doubt as to the source from which the original report of October emanated.

Senator Gibson.

Senator Gibson of Montana represents some of the people of Montana together with a few railroads, and is one of the supporters of Mr. Maxwell's doctrines. He believes that the land laws are bad, that the people of the West are not capable of enforcing their provisions, and that they should be repealed. So does "Ozone George." There are others who believe that the land laws are good, but that their administration has been too lax.

The AGE belongs to the latter class, although we believe that many of the land laws could be improved by slight amendments. Mr. Maxwell's clients would doubtless profit should the land laws be repealed. Land scrip would double in value and railroad lands would sell quickly at advanced prices. How about the homeseeker who can only irrigate a few acres of his homestead along a narrow strip of valley, and who needs more land for a few head of cattle or horses? He can buy of the railroad "scrip" a few acres if he has the money.

Returning to Senator Gibson and the part he has taken in the campaign favoring the repeal of the land laws. He has become so conspicuous by his recent utterances at the Irrigation Congress at Ogden, and by printed matter which he has furnished the public, that even the Secretary of the Interior, who once recommended the repeal of these laws, has said nothing for a month or more about the matter. Evidently, Senator Gibson's attitude has so impressed the Secretary that the latter has come to believe that the hotbed of fraud under the laws must lie in the Senator's immediate neighborhood, for he has withdrawn all lands from entry, under the laws which are so iniquitous in the eyes of Mr. Maxwell's champion in the Senate, in the Great Falls Land Office. It remains to be seen whether the Secretary will employ the same methods elsewhere. We doubt his authority to carry out such an order. He has no good reason for so doing and is limiting Acts of Congress in a way that establishes a dangerous precedent. We hope that Senator Gibson will enjoy the relief that is sure to come to a man who has won a partial victory. Lands in the neighborhood of his home can not be disposed of under the Desert Act, the Timber and Stone Act, or the Commutation Clause of the Homestead Act.

Merit Sometimes Counts.

When a man builds a house he secures the services of an expert along that line: when he wishes to have a record kept of his business transactions he hires a bookkeeper: when he desires to beautify his grounds he makes a contract with a landscape gardener. Our best governed cities and states require certain qualifications for eligibles for the various administrative offices. The government generally demands that each man have some fitness for the place he occupies, but in some instances a man, temporarily at least, secures an office where technical qualifications are required through intrigue or political influence, regardless of his ability to perform the work that is presumed to devolve upon him.

We have given Mr. George H. Maxwell some study and believe we understand his methods and believe we know why he has certain convictions. In this study we have necessarily been forced to look up the records of some of the men who have been closely associated with him. Some of the developments following this investigation have been interesting, and we propose from time to time to discuss them frankly in the columns of the AGE.

One man who was advertised extensively by Mr. Maxwell's organs is at present at the head of the reclamation service. Mr. Newell may not have intentionally permitted himself to be influenced by Mr. Maxwell in the past eighteen months, but from the evidence we have before us it would seem that an understanding has existed between the two men from the beginning of the struggle for position and extended influence which began in Chicago during the memorable session of the Irrigation Congress several years ago.

It would be presumed that Mr. Maxwell would want a man at the head of the reclamation service who did not know too much about irrigation or engineering construction work. A man that was thoroughly qualified in such work would not be liable to take the advice of a professional lobbyist, and Mr. Maxwell knew this when he published Mr. Newell's record far and wide during the spring of 1902.

In looking up Newell's professional career we find that he has had no experience in the work he now assumes to direct. If any of his friends, or if he can furnish us with more information we will be glad to publish any and all details. He broke into the American Society of Civil Engineers in some way, but it was not because he had done such work as would warrant his being accepted as a member.

He graduated from the Boston School of Technology as a Mining Engineer and Geologist, and went to the mountains of Colorado, where he worked for about three months. He worked in the East along the same lines for several months longer and then accepted a place with the Geological Survey. The Division of Hydrography was created later and he was promoted to the position of chief. What is the Division of Hydrography? The principal work of the Division consisted in measuring streams, and this is what Mr. Newell did until called to construct canals and reservoirs on a large scale for the Government. If ten or twelve years' work guaging streams makes a civil engineer of a geologist and mining engineer, we are greatly deceived as to the character of the apprenticeship under the Geological Survey.

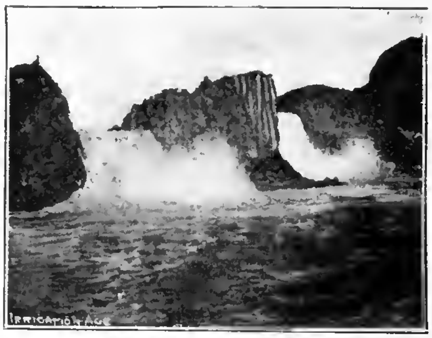
IMMENSE IRRIGATION PROJECT.

LARGEST OF ITS KIND IN THE UNITED STATES, THIRD LARGEST IN THE WORLD.

It contemplates Reclamation of a Tract of Land as Large as State of Rhode Island, in Snake River Valley, Idaho.—Will Cost Millions.

The greatest irrigation project in the United States, and the third largest in the world, is well under construction in Idaho. It is under the management of a corporation originating in Salt Lake City. The plan contemplates an expenditure of approximately $2,500,000, and the reclamation of 271,000 acres of the best agricultural lands in the great Snake River valley of Southern Idaho.

The principal shareholder in this gigantic enterprise is Frank H. Buhl, the iron operator of Sharon, Pa., who is the president. He is associated with P. L. Kimberly, another wealthy man, and Walter G. Filer, manager, from the same city, who is also the vice-president. They have three western men, familiar with irrigation and canal building, in the syndicate. These are Colonel S. B. Milner and Frank Knox, bankers of Salt Lake City, and I. B. Perrine, of Blue Lake, Idaho, rancher. M. B. DeLong, of Utica, N. Y., is the secretary and treasurer, Paul S. A. Bickel, of Helena, Mont., irrigation engineer, is chief engineer.



TWIN FALLS, IDAHO.

A tract of land as large as the state of Rhode Island is to be brought under ditch and make ready for farming and fruit raising. The lands were formerly set aside for a National Park because of the wonderful scenery. By a deal with the State officials, who are taking advantage of the Cary Act of 1894, making a donation of 1,000,000 acres of arid lands to each State that will construct canals and have the lands reclaimed, the great park will become a garden of small farms and vineyards.

The enterprise includes the construction of two irrigation canals and laterals that will have a combined length of over 1,000 miles. The main canal will be sixty-nine miles long and eighty feet wide at the bottom. It will carry a large river from the original Snake channel. For the purpose a dam eighty feet in height will be constructed across the Snake. Sufficient water has been appropriated from the natural flow of the big river to supply the canal and leave an abundance for use by those owning riparian rights farther down the stream.

UNDER THE CAREY ACT.

The Twin Falls Land & Water Company is the title of the new corporation. Under the provisions of the Carey Act only 160 acres of this land can be held by one person. The company plans to have smaller holdings than this, and many of the farms will be of the twenty-acre Utah class. The country is particularly adapted to fruit raising and general mixed farming. Alfalfa is the chief forage plant, and grows to

STRETCH OF RIVER ABOVE TWIN FALLS

perfection. The country is also a choice spot for growing prunes, peaches and similiar fruits.

The construction of these canals and laterals will probably require a period of five years' hard work. When completed, the system will be the most perfect in existence in the irrigated world. It is planned, later, to have electric car lines reaching every farm and orchard, and when the country is settled, to secure the rural mail system. Public telephones and all modern conveniences are to be added to the comforts of making homes under the canals. Some settlers are now located on their lands, awaiting the coming of the water ditch. The company announces that the work will be pushed as fast as possible, until every acre of the large tract has been placed under the canal. Water rights are to be sold to actual users at reasonable rates. This amount of land will support a number of good towns, when once under cultivation.

GENERAL DESCRIPTION.

The Snake river, or Shoshone river, has its head around the National Park, Shoshone mountains and Jackson's Hole, where there is perpetual snow, and flows from Montana and the National Park through Wyoming, into Idaho, through the foot hills for several hundred miles, when it reaches the great American desert of sage brush. This sage brush frequently grows to the height of eight feet, but generally is about three feet and so thick that it is inconvenient to walk fast through it. A peculiar thing is noticed on the maps: west from the National Park in the foot hills,

GRADING ON BIG TWIN FALLS IRRIGATION CANAL.

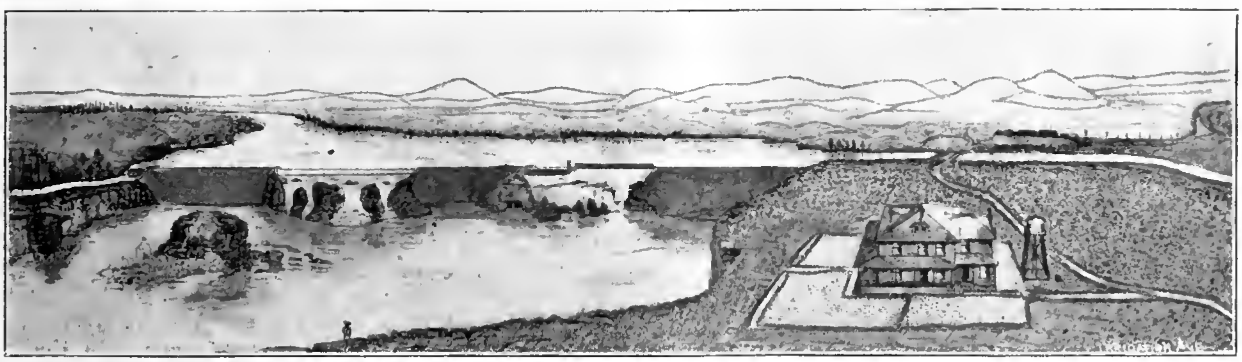
all the rivers sink and disappear. This is accounted for by a large flow of lava which covers the Snake river valley, which at different times, as one can see, has been overflown by the lava from volcanoes in and

around the National Park. The rivers at this time, when the lava was hot and sputtered and boomed, fought their way under the lava and today they come out along the 600 foot high walls of the Snake river in the shape of huge springs as large as the largest in existence. One collection of springs called the Thousand Springs, of 5,000 second feet flow, falls 200 feet over the lava walls. The Snake river has also had its troubles, and while it spread out and went over the lava above American Falls and down as far as the head of the great canal, it finally got the best of it here, and at the three islands where the dam, or rather three dams are being built, it broke through the lava and boiled and sputtered and fell into the large crack of lava while cooling and now it falls in jumps of ten to 200 feet at a jump, for sixty to eighty miles, leaving a mesa from 100 to 800 feet above the bottom of the Snake river canyon. This mesa or what is known as the Snake river valley is a vast plain of sage brush, without a break of any great depth, with lava ash soil and sandy loam, making a most fertile foundation for any kind of fruit or cereal which grows in great abundance when the soil is softened by moisture.

GENERAL VIEW NEAR SITE OF TWIN FALLS DAM.

THE DIVERTING DAMS.

To get water up to the level desired to irrigate the land, it is necessary even here to dam the river and raise its normal level about forty-nine feet, or from elevation 4048 to 4097, high water surface in canals. At the point selected for damming the river there are three channels with rocky islands between. Two of these channels are only occupied at extreme high water, the stream being ordinarily confined to the north channel. There are therefore three dams, two of which will have an extreme height of seventy-six feet and the third sixty feet in height. These dams will each have a width of twenty feet on the crest, at a height of eight feet above high water mark in the canals. They are being constructed of massive embankments of rock, laid dry, having a minimum width of 150 feet at base, reinforced at the upper side with an embankment of earth having a base width of 300 feet, the total width of bottom being 460 feet, the upper slope being four to one and paved with rock rip rap. The aggregate length of the three dams is about 1,100 feet, and the spill-ways will be over 900 feet long. The islands are to be used as spill-ways, to take care of the excess of water beyond the capacity of the canals. The top of the south island is to be cut down to the bottom of the canals and provided with a battery of ninety-nine gates, each 5x10 feet in clear, extending across the island, a distance of 530 feet. It is safe to say no such assembly of gates arrayed in one continuous line has ever been used upon any irrigation works in America. These gates are held in place by steel frames enclosed in concrete and



TWIN FALLS DAM WHEN COMPLETED AND COMPANY'S HEADQUARTERS.

are expected to control the flow of the river at all times, and have a capacity of 63,000 second feet, without raising the water level above the high water mark in the canals. The greatest flood discharge of the river is 50,000 second feet and the maximum waste way provided in spill-ways, tunnels and canals is 166,000 second feet, 3 1-3 times the maximum. The dams are provided with a central core of wood, founded on bed rock and anchored thereto by concrete

base wall. This core consists of a double thickness of two inch plank, spiked to uprights two feet apart. Above this core or fence, all the material is carefully puddled with water; below it, the rock is loose and open and free to drain out any water that may find its way through the ponderous mass of puddled earth behind it, and through the core. All the possible leakage water is thus robbed of its velocity head and has no power to do harm to the structure, even should it appear.

INTERESTING FEATURES OF HEAD GATES.

Among the interesting engineering features of the works are the canal head gates, which are being built by the American Bridge Company. They are radial gates, a segment of a cylinder, hung on the side walls or piers between the gates, where the axle goes through each wall. These walls have a steel frame fastened on bed rock. The gates and frame are all of structural steel, the facing only of wood, with a rubber flap, or belt, connecting the division walls and the gates against which the water presses and makes them water tight. The gates are twelve feet wide by eleven feet high, hoisted by chains and windlass from bridge above. With this form of gate the pressure is not felt, as the force resisting is at right angles to the surface and transferred to the axle and only the weight of the gate is considered. This type of gate is to be used throughout for waste gates, lateral gates, head gates, controlling gates, etc.

TUNNELS UNDER THE DAM.

Another novel feature is the great tunnel under one of the islands and under the battery of waste gates, by which the river is to be diverted from its present bed, while the north dam foundation is being laid. From that time until the completion of the dam, the water will necessarily have to flow through the tunnels. The tunnels are four in number 10x10x80 feet, lined with concrete, which are now under construction, and under the level of the river, but coffer dammed to keep the water out and about fifty feet under the surface. The average flow of the river is 6,000 second feet while the tunnels will have a capacity of 10,000 second feet and are to be closed by eight large steel gates, brass or bronze mounted, and each gate is 5x10 feet in the clear and strong enough to withstand a pressure of seventy tons. The controlling device or capstan for raising is ball bearing and made by the Coffin Valve Company, of Boston. The approximate cost of tunnels and gates is $50,000. The gates can be raised or lowered by one man, but probably will only be used at the time when the third dam or last opening is being closed. When, however, these gates are closed, the water will form a large reservoir which will extend up the river six or seven miles and take two days to fill. It is expected to be a busy time for placer miners in the canyon below, as it will give a chance for the examination of the bottom of Snake river, which has placer gold of considerable quantity that has never been exposed. This will also be an interesting time for those curious to see the perpetual stream, once held at bay.

THE CONSTRUCTION PLANT.

The construction of the dam is being carried on by Messrs. Faris & Kesl, of Boise, Idaho, who have built a private temporary dam across Snake river, 800 feet long. A channel in the middle, sixty feet wide by twenty deep was filled by large cribs filled with rock. This dam raised the water about five feet and forced it into a canal of about one-half a mile in length, made by clearing the loose rock and debris from bed rock, and anchoring a fence with bolts to the same. This conducts the water to a platform of rock in the canyon, where a power plant is established. A turbine wheel operated by 100 second feet of water falling thirty-one feet which drives a 200 kilowatt direct current generator. The current is used to run electric drills, to blast the two miles of rock in the canal, which is used in construction of the dams. Electric shovel is used as a derrick to hoist rocks of a yard and more into cars hauled by electric trolley motors. These cars are hauled to the dam and raised with a Ledgerwood cable. A cable stretched on towers lengthwise of the dams, with a clutch carriage operated by smaller cables and when the skip or body of the small car is in midair is tripped and the rock comes down on the other rock with great force, assuring the settlement of the whole mass. All this is done by electric power furnished by the contractors. This has been a large expense to the contractors, but will be money well expended in the long run.

CANALS.

The main canal now under construction is eighty feet on the bottom and is to carry a depth of ten feet of water. The slopes of banks are two to one and thirteen feet high above the center of the canal. The canal on an average, banks and all, takes up a width of almost 200 feet. The first four miles have considerable solid rock, but from there on it is excavated in a lava ash soil, very fine and mellow. One fill is thirty-four feet high, and there is to be no flume on the entire length. About twenty-five miles of canal will be completed this year and is expected to be completed by Christmas. One place on the main canal, eight miles below the head, a dam of earth is being constructed across a large draw called Dry Creek, to avoid a long detour of three miles. The dam is forty-eight feet high in the lowest place in the draw and one mile long. To make the dam firm and have it settle, water has been piped three and one-half miles from a warm spring, and as the earth is put in, it is sprinkled and rolled. Fifteen per cent of moisture is used in the earth. This dam will form a reservoir which will hold a supply for three days run, in case of break or repairs. The grading is done with Fresno scrapers drawn by four horses, and wheel scrapers and slips in the usual way. As the canal is through a desert the construction camps exceed thirty in number. On the whole there are about 400 teams and 500 men engaged upon the canal and dam. These camps, although most of them are near water, it is yet so far to the river, down in the impassible canyon, 500 feet deep, that in order to get water, a steam or gasoline hoist raises it in a barrel suspended on a cable 600 feet long, on an incline into the canyon. In this way water is hoisted to the rim and then hauled in tank wagons some five or six miles. The grading of the twenty-five miles of canal is under contract with Nelson Bennett Company, of Tacoma, Wash. The first twenty-five miles of large canal reaches a point from which 30,000 acres of land can be reclaimed and are already thrown open for settlement.

Several thousand acres have been filed upon and some of the settlers are clearing and breaking ground in advance of the coming of the water next spring. The land has a very gentle slope.

PUMPING FOR IRRIGATION.*

BY JOHN J. VERNON AND FRANCIS E. LESTER.

New Mexico College of Agriculture.

INTRODUCTION.

Without water nothing will grow. It is as much a necessity to vegetable life as air or light. Moreover, to secure the best results vegetation requires water at certain intervals. Nature sometimes fails to provide this supply when most required, and the work of man steps in with the practice of irrigation. Herein lie the advantages which irrigated regions possess over those which rely solely upon the rainfall.

New Mexico is blessed with a genial climate and, for the most part, with a fertile soil. The conditions existing in her valleys and on many of her plains are, except for the matter of rainfall, exceedingly favorable to agricultural pursuits. Farming operations may here be carried on the whole year through. But the amount of rainfall in the territory is light, averaging in different localities not more than eight to sixteen inches in the year. This being the case, it is evident that the solution of the problem of successful agricultural work in New Mexico is a sufficient quantity of water for irrigation. It was with a view to demonstrate the practicability of providing such a supply of water from the underflow that the experimental work described in this bulletin was undertaken.

PUMPING FOR IRRIGATION FROM WELLS.

The funds available for the prosecution of the investigation conducted were limited, but enough has been done to emphasize its importance to the development of the agricultural interests of our territory.

DEVELOPMENT OF PUMPING PLANTS.

Irrigation by pumping, no doubt, grew out of gravity systems. From irrigation by gravity it was only a step to that of pumping from river channels and canals to high-lying contiguous areas. In natural sequence, pumping would follow upon lands lying slightly above gravity systems or upon areas having no water supply other than that of the underflow.

Irrigation by pumping dates far back in history. "We are told that 'the numerous remains of huge tanks, dams, canals, aqueducts, pipes and pumps in Egypt, Assyria, Mesopotamia, India, Ceylon, Phœnicia, and Italy, prove that the ancients had a far more perfect knowledge of hydraulic science than most people are inclined to credit them with.'"

At the present time much greater areas are irrigated by pumping from wells than is generally supposed. King, in writing on this subject says: "It is further estimated for the whole Indian Peninsula, British and native, that no less than 300,000 shallow wells are in use, while they serve certainly more than 6,000,000 acres of land." Large areas are being successfully irrigated by pumping from wells in the various sections of the United States, notably, parts of the great rice region of the South; considerable areas of fruit lands in California; and certain alfalfa and fruit sections in Colorado, and elsewhere.

GENERAL IMPORTANCE AND LOCAL CONDITIONS.

Few parts of New Mexico are favored with an abundant supply of water for irrigation purposes. To one familiar with the agricultural conditions of the territory, it is hardly necessary to emphasize the importance of such a supply. In an irrigated region it may mean all the difference between heavy loss or large profit in the management of a farm.

Throughout the whole length of the Rio Grande Valley in New Mexico, which includes a large part of the lands of the territory at present devoted to agriculture, there has seldom been in the past ten years or more, a sufficient quantity of water in the river throughout the irrigation season to meet the demands of the lands at present in cultivation. With the increase of the area in cultivated lands, the conditions grow worse instead of better. Enterprises that have sought to make the existing supply available for a greater length of time by means of storage reservoirs have been contemplated but never successfully completed. As a result, the average New Mexico farmer in the Rio Grande Valley has been impressed with the necessity of turning his attention to means of supplementing the available water supply. The question of pumping for irrigation is therefore of great importance, in the first place, to such farmers. In the second place, it affects the question of reclaiming immense areas of fertile lands suited to agriculture that exist in New Mexico, and that lack only a water supply to bring them into cultivation. As a means of providing such a water supply the question of pumping for irrigation is attractive for two reasons. If it can be shown to be successful at all, it provides a supply that is reliable and secure, subject to no fluctuation beyond possible breakage of machinery, and making it possible to put the water on the land at the exact time required. Secondly, it places the farmer in an independent position, making him independent of water companies or ditch corporations with their sometimes annoying regulations.

LOCAL CONDITIONS.

The conditions existing in the Mesilla Valley, where the experiment station is located, are probably fairly typical of those to be found throughout the greater part of the valley of the Rio Grande. Largely as a result of shortage of water in recent years, the farmers of the Mesilla Valley have turned their attention to the cultivation of those crops that can not be seriously injured by an uncertain water supply. Chief among these crops, is alfalfa, and in the Rio Grande Valley, at least, the cultivation of orchards, vineyards, corn and vegetables on lands relying entirely upon river water for irrigation has received much less attention in recent years

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than formerly. Few farmers have cared to go to the expense of planting a crop or orchard, and cultivate it perhaps for years with the risk of a possible loss of the entire crop, from shortage of water through the summer months.

SOIL STRATA AND UNDERFLOW IN THE RIO GRANDE VALLEY.

No very definite statements can be made regarding the soil strata of the Rio Grande Valley in the absence of a systematic investigation of the question. We can only be guided by the incomplete data secured on this important question from the little work that has been done up and down the valley. From this it becomes apparent that conditions do not vary much throughout the length of the Rio Grande Valley in New Mexico which is cultivated. In a general way, the valley consists of made lands, that is to say, sand, gravel and sediments that have been washed down and deposited in the valley through past ages. What the depth of this deposit is, it is impossible to state with any degree of accuracy but it is undoubtedly very great in some parts.

SOIL STRATA.

The various strata found throughout the valley consist of layers of soil,. sand and gravel, of varying degrees of coarseness, with occasional layers of hardpan or clay. Sand evidently forms the greater part of the strata in the valley and in many parts extends to the surface, although usually covered by a layer of sediment and rich soil varying in thickness from a few inches to many feet. It seems to be generally true that most of the valley is underlaid at a reasonable depth with gravel beds sufficiently thick to procure from them by means of slotted strainers an ample water supply. In the Mesilla Valley a gravel bed is usually found at from twenty to eighty feet in depth although there is no certainty as to the depth at which it will be found or the thickness of the stratum.

Along the foot hills of the valley the question of underlying strata is a much more uncertain one, but in the valley proper we know that large quantities of sand and varying thicknesses of gravel will be met with. Only more extensive exploitation will demonstrate what may reasonably be expected to be encountered in sinking a well.

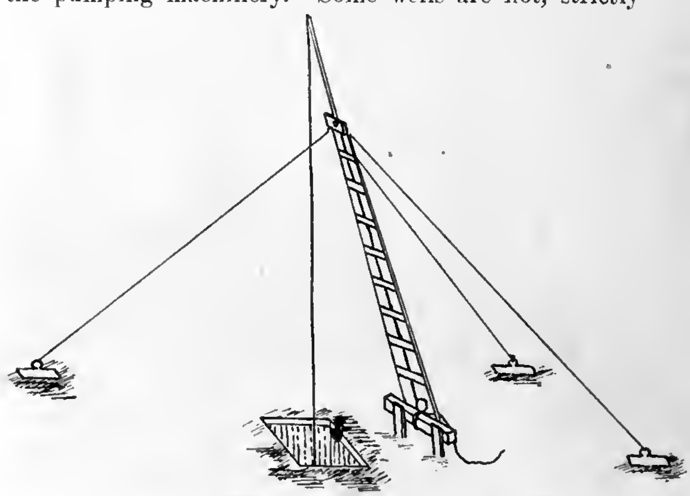
UNDERFLOW.

When it comes to the matter of underflow the question is no uncertain one. Throughout the whole length of the valley proper, water will be found at a depth of from four or five feet to twenty or thirty feet, depending upon the height of the ground above the level of the river bed. This water appears to be generally of a good and fairly uniform quality throughout the valley, though near to the foot hills the quality is an uncertain thing. In the matter of quantity, it seems to be more a matter of providing means for making the water available than any question as to the underflow. Some New Mexico farmers using gauze covered strainers in a small size quite unsuited to the securing of large quantities of water, have met with very unsatisfactory results, as the strainers have filled up and the flow greatly diminished; and they have come to the erroneous conclusion that the water was not there. Where suitable strainers have been placed in a gravel bed which allows the free passage of the water to the well there has been no complaint of the amount of the supply.

The whole valley appears to be underlaid with water. Whether this is an immense reservoir or a river flowing in any direction is not certain, arguments being advanced to support both theories. We do know, however, that the amount of water below is enormous and amply sufficient to meet all reasonable needs. It is probably safe to say that a sufficient quantity of water exists under every acre of irrigable land in the Rio Grande Valley which if raised to the surface would irrigate it; and there seems to be no reasonable ground for believing that this supply will cease to exist.

WELLS.

For convenience, wells may be classified under two heads, viz., open wells and pipe wells. The latter are sometimes termed driven wells. For the purpose of this bulletin, an open well is defined as one in which no part of the well is utilized as an aid either in lifting or directing the water to the surface of the ground. A pipe well, on the other hand, is one to which the pump is directly attached to the well itself; it therefore may be said to form a part of, or a necessary adjunct to, the pumping machinery. Some wells are not, strictly



TIMBER DERRICK USED IN SINKING STATION WELL.

speaking, under either of these heads, but for the present discussion such may be ignored, since all wells referred to in this bulletin come in one or the other of these classes.

OPEN WELLS.

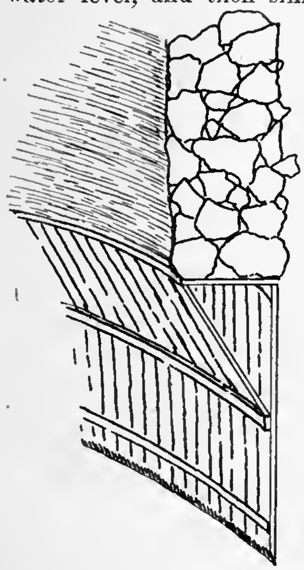
Everything being equal, that is, in capacity, cost, ease of sinking, and the life of the well, the open well is the better. Under the conditions existing in the Rio Grande Valley and other similar areas, the open well, however, is a difficult and costly undertaking, and until improved and less expensive methods are devised, the first cost of an open well will preclude its general adoption. By referring to the tables shown in this bulletin, it will be seen that the experimental six-inch station well, costing $150, has a capacity equal to or greater than that of open wells, costing several thousands of dollars. A number of open wells, costing considerable more than this six-inch pipe well, have a less capacity. Nevertheless, the open well or its equivalent, with its accompanying minimum cost for lifting the water to the surface of the ground, is the ideal that should be constantly borne in mind.

METHOD OF SINKING.

A large area of the irrigable land in New Mexico is underlaid with sand, and the great difficulty in sink-

ing wells in such sand arises from the tendency of the sand to move with the water; "since the specific gravity of sand is only about 2.65, just as soon as a pressure greater than three feet is developed to force the water out of the sand, the sand must move with it." In sinking an open well, it is usually necessary to remove the water as fast as it accumulates. The effort must, therefore, be to minimize the movement of the sand which is forced upward into the bottom of the well by the pressure from without.

There are two principal methods used where sand forms the bulk of the under-stratum. The first of these is to sink the well only a few feet below the water level, and then sink several perforated pipes or strainers in the bottom of the well. These pipes will usually flow when the head of water in the open well is pumped off. The second method, and the one by which probably the most permanent well can be secured, but at a comparatively high cost, is by building a circular wall of masonry, say two feet thick, upon a platform supported by a wooden curb some two inches thick, and from four to six feet long. (See Fig. 1.) The weight of the wall causes the curb to sink deep into the sand, considerably in advance of the excavation within. The pressure of the sand and water within the curbing thus tends to equalize the pressure from without and therefore to greatly expedite the work. In making an open well of this type, it is usually desirable at the finish to have the curbing penetrate a short distance into the gravel stratum so as to shut off further entrance of sand into the well from without the wall. In sinking the water is usually kept down by a centrifugal or other kind of pump capable of handling a large quantity of water.



MASONRY CURB ON WOODEN PLATFORM.

PIPE WELLS.

Pipe wells are frequently sunk by drilling. Under the conditions existing in the Rio Grande Valley, however, in which sand or sand and gravel, form the water bearing stratum beneath the surface of the soil, they are either driven or sunk by means of a sand-bucket, in which case some form of strainer is common. With small wells three inches or less in diameter, the strainer or point, as it is frequently termed, is fastened to the lower end of the pipe and driven with the pipe to the desired depth. Large wells of this type have been driven, but it is customary with such large wells to sink the open pipe first and lower the strainer inside to the bottom. The pipe is then jacked up until the entire length of the perforated part of the strainer is exposed.

STRAINERS.

There are three types of strainers: The common strainer, consisting of a perforated pipe covered with brass gauze or closely wrapped with brass wire; the "Cook's" (a strainer consisting of a pipe cut with horizontal slots, wider on the inner side); and the slotted strainer. The first two are too well known to require special mention here. They are used largely to secure water from sand. The last named strainer, which is illustrated in Fig. 12, consists of a pipe perforated by round holes or oblong slots, and is used in drawing water from a gravel, or a gravel and sand, stratum.

INFLUENCE OF CAPACITY.

An increase in the capacity of a well means that more water can be secured by pumping off the same head, or that the same amount will be supplied when pumping off a somewhat less head. In the latter case, the water would stand nearer the surface of the ground while pumping, and for this reason the lift would be less, thus reducing the cost of pumping. It is evident, therefore, that the cost of pumping a given volume of water diminishes with the increase in the capacity of the well. It naturally follows that a saving in the cost of pumping will soon compensate for the relatively larger expenditure for the construction of a well of greater capacity. The size of the well, and the length of the strainer both affect the capacity of the well, if the water enters from the bottom or through the sides near the bottom.

SIZE OF THE WELL.

The area of the bottom, as well as that of the sides of the well, increases as the well grows larger, and it is thus evident that the greater the area the greater the space through which water can enter the well. From this we conclude that the capacity of a well, other things being equal, increases with its size.

LENGTH OF STRAINER.

Under equal conditions, and within the limit of the carrying capacity of the pipe, it may be said that the longer the strainer the greater its capacity. This increase in capacity is brought about in much the same way as the increase in the capacity of the well with its size. King says: "Leaving the bottom of the well out of consideration, it is clear that doubling the depth of the well in the water bearing beds doubles the area for water to enter. * * * This capacity increases in a somewhat slower ratio than the depth." * * * This statement also applies to the increase in capacity of a well through its increased size.

DEPTH OF WELL.

So long as the head of water while pumping is above the strainer, the depth of the well does not affect the capacity, unless the conditions differ. This statement refers to pipe wells with strainers.

THE STATION WELL.

The experiment station well is forty-eight feet deep and consists of an open well dug to water level, in the bottom of which is sunk a six-inch pipe, 21½ feet long, with a 12-foot strainer below the pipe, located in a water-bearing gravel stratum. To facilitate the attachment of pumps, the pipe was allowed to project six inches into the open portion of the well.

The following equipment and materials were used in sinking the well:

(To Be Continued.)

Somebody asks: Is the Weather Bureau man responsible for bad weather? To give an evasive answer: We should say not; the bad weather is responsible for the weather bureau man.

THE PRIMER OF IRRIGATION.

Chapter VIII.

HOW PLANT FOOD IS TRANSFORMED INTO PLANTS.

The growth of plants from the seed to the harvest, or fall of the leaf, may be divided into four periods, during each of which they live on different foods and expend their energies in the production of different substances.

This is important to be well understood, for plants can not be dieted like animals, they need certain provisions at certain periods of their growth, and if not supplied with them the result is failure, or a sparse crop. A farmer feeds his chickens egg-producing food, his cows milk-generating fodder and mash, and his cattle fat-making provender. He might as well deprive his animals of their necessary stimulating food and expect them to go on laying eggs, furnishing milk and growing fat, as to expect his crops to succeed without providing them with the requisite material to arrive at perfection. But, to proceed.

These four periods in the life of plants are:

First—The period of germination, that is, from the sprouting of the seed to the formation of the first perfect leaf and root.

Second—From the unfolding of the first true leaves to the flower.

Third—From the flower to the ripening of the fruit or seed.

Fourth—From the ripening of the fruit, or seed, to the fall of the leaf and the return of the following spring.

Of course, in annual plants, when the seed or fruit is ripe or harvested, there are no more duties or functions to perform, hence the plants die, having accomplished the object of their existence. But in the case of perennial plants, there are important things to be done in order to prepare them for the new growth of the ensuing spring.

PERIOD OF GERMINATION.

1. To sprout at all, a seed must be placed in a sufficiently moist situation. No circulation can take place, no motion among the particles of the matter composing the seed, until it has been amply supplied with water. Indeed, food can not be conveyed through its growing organs unless a constant supply of fluid be furnished the infant plant and its first tender rootlets. This does not mean drenching the immature plant with water, but supplying it with moisture. A child needs feeding just as much as an adult, but not to the same extent, and over-feeding kills the young plant as quickly as the young animal. The reason is plain, if the reader remembers what was said in the last chapter, in which it was specified that water is a chemical compound of oxygen and hydrogen. In this state it is too strong a food for the young plant, and "drowns" it out, as the saying is. But in a state of moisture, the chemical nature of the water is altered somewhat and becomes available to the juices in the seed, whereby the germ is enabled to grow and fulfill its mission without meeting with a premature death. It is water that is the parent of moisture and without water, of course, there can be no moisture. Nevertheless, throughout this entire book, it is moisture that will be insisted upon; when plants have that, the whole object of irrigation will be accomplished, unless it be the intention to grow aquatic plants.

Now, this moisture must be constant during the entire life of the plant, not liberal one day with the next day dry, and so on, alternately, as some say may happen in the case of pork for the purpose of making alternate layers of fat and lean in the bacon, but not in the case of vegetation.

2. A certain degree of warmth is necessary to germination. This warmth varies with the seed, some seeds, those containing much starch, for instance, requiring more, and slow germinating seeds less. What is needed is not too early a planting and protection against any inclemency of the weather from frost or cold rains, and not too late a planting in locations where there are no winter or spring frosts, to avoid too great a heat from the sun, which is as dangerous to tender plants as frost. "Warmth" is a sufficiently descriptive word to make the meaning clear.

3. Seeds refuse to germinate if entirely excluded from the air, even where there is plenty of moisture. Hence, in a damp soil, seeds will not show any signs of life for a long time, and yet when turned up near the surface within reach of the air, they speedily sprout. The starch in the grain intended to feed the germ will not dissolve in water, so it happens that the farmer, sometimes, in ditching or digging a well, throws up earth that has lain many feet below the surface for years, perhaps ages, the length of time makes no difference, from which sprout plants of unknown varieties. They have never lost their vitality. The "oat hills" in the southern part of California are familiar examples. Year after year a good crop of oats springs up without planting, cultivating the surface being sufficient to bring the buried grain within reach of the air. It is said that the old Padres originally sowed this grain broadcast wherever they went, taking a sack of it on their horses, and as they traveled along cast handfuls of it in the most favorable spots. This grain grew to maturity year after year, going back to the soil unharvested, there being nobody to gather it. The civil and criminal records of the southern California courts are full of lawsuits and murders growing out of struggles to obtain and retain possession of these "oat hills."

A friend for whose accuracy there is abundant evidence, cites a case that happened to him personally in a small valley in the semi-arid region. Wanting water he began sinking a well and went down one hundred feet before reaching moist ground. That ground was a soft black loam, and desiring to keep it for a top dressing, he laid it aside for future use. Not long afterward seeds began sprouting all over it and, helping the sprouts with a little water to keep the soil moist, he raised a thick crop of fine sweet clover. The seeds had never been planted by the hand of man, for the formation of the soil indicated that it might have been in the same condition since the Deluge.

4. Generally speaking, light is injurious to germination, wherefore, the seeds must be covered with soil, and yet not so deep as to be beyond the reach of air. Sowing grain broadcast leaves much of it exposed to the light, and even after harrowing, it does not germinate, being food for birds and drying up or burning up in the sun. In light, porous soils, it is common, however, to sow broadcast and then plow under, afterward harrowing lightly. It is also common in the arid

and semi-arid regions to plow the grain in "dry" in the summer or dry months, and when the rains come in the autumn, or say, in November and December, the grain sprouts in a few days.

The reason why light is prejudicial to germination and why atmospheric air is necessary is because during germination seeds absorb oxygen gas and give off carbonic acid, and they can not sprout unless oxygen gas is within their reach, the only place where they can obtain it being from the atmosphere. In the sunshine the leaves of plants give off oxygen gas and absorb carbonic acid, while in the dark the reverse takes place. Hence, if seeds are exposed to the sunlight, they give up oxygen which they need and absorb carbonic acid which kills them.

5. During germination, acetic acid (vinegar) and diastase are produced, as mentioned in the last preceding chapter, whereby the insoluble starch is converted into sugar, which is soluble and can be absorbed as food by the youthful plant.

6. The tender young shoot which ascends from the seed consists of a mass of organs or vessels, which gradually increase in length, sometimes "unroll" into the first true leaves. The vessels of this first shoot do not consist of unmixed woody fiber, that is not formed until after the first leaves are fully developed. In the meantime the young root is making its way down into the soil seeking a storehouse of nourishment upon which it can draw when the sugar of the seed shall all have been consumed.

These phenomena are brought about in the following manner: The seed absorbs oxygen and gives off carbonic acid. This transforms a portion of the starch into acetic acid, which aids the diastase to transform the insoluble starch into soluble sugar, or food that can be taken up into the plant. It also dissolves the lime in the soil contiguous to it, and returns into the plant, carrying the lime or other dissolved earthy substances with it. The seed imbibes moisture from the soil, and this dissolves the "sugary starch," so to speak, and it all goes into the circulation, and the plant is enabled to grow and develop its first leaves. It is like a baby fed on milk.

When the true leaves have expanded, woody fiber begins to make its appearance, which can be readily understood by attempting to break the plant stalk, a thing easily done before the first leaves appear, but not so easily afterward. The sugar in the sap is now converted into woody fiber, the root drawing up food from the soil, and the leaf drinking oxygen and carbonic acid from the atmosphere. The moisture must still be constant, for the root can not absorb food unless the latter is properly dissolved.

FROM THE FIRST LEAVES TO THE FLOWER.

The plant now enters upon a new stage of existence, deriving its sustenance from the air and the soil. The roots descend and the stem shoots up, and while they consist essentially of the same chemical substances as before, they are no longer formed at the expense of the starch in the seed, and the chemical changes of which they are the result are entirely different.

Here is where the farmer will make a fatal mistake if he relaxes his vigilance. The whole energy of the plant is directed toward one single goal, that of preparing for the flower which is the forerunner of the fruit. What the flower is, that will be the fruit.

The leaf absorbs carbonic acid in the sunshine and gives off oxygen in equal bulk, and the growth of the plant is intimately connected with this absorption of carbonic acid, because it is in the light of the sun that plants increase in size. Now, by this function of the leaf, carbon is added to the plant, but it is added in the presence of the water of the sap and is thus enabled by uniting with it to form any one of those numerous compounds which may be represented by carbon and water, and of which, as was shown in the last chapter, the solid parts of plants are principally made up. This period may be called the period of "plant building," the plant utilizing every material that will bring it up to the condition of flowering.

The sap flows upward from the roots, through which have been received the silica, potash, soda, phosphorous, etc., in solution, and reaching the leaves, meets the carbonic acid flowing in through the myriad of mouths in the leaves, and then flows along back downward to the roots, depositing, as it descends, the starch, woody fiber, etc., which have been formed by the action of the carbonic acid. Thus the sap circulates round and round like the circulation of blood in the veins of an animal, except that its heart is not a central organ, but an attraction of affinities among the substances which enter into plant life, affinities constantly pursuing each other through the veins or capillaries of the plant, and forming unions, the products of which add to the growth of the plant and enable it to accomplish its destiny.

During this ante-flowering period there are produced in the plant not only woody fiber, but other compounds which play an important part in a subsequent stage of its existence; one of these, the most important, is oxalic acid, which has already been alluded to. This acid seems to be formed at this period to aid in perfecting the future fruits that will follow the flower. What is curious about these various acids now formed is that many of the plants are sour in the morning, tasteless during the middle of the day, and bitter in the evening. The reason is, during the day these plants have been accumulating oxygen from the atmosphere to form acids, but as the day advances this oxygen is given off, carbonic acid is imbibed and the acids decomposed. Hence the sourness disappears, but the materials are in the plant ready for use when required—the acid storehouse is filling against the day of need.

In the case of wheat, barley and other grains, the chief energy of the plant, previous to flowering, is expended in the production of the woody fiber of its stem or stalk, and growing branches, drawing up from the soil for that purpose the various ingredients they require from among the inorganic elements, which unite with the vegetable acids in the sap and form compounds which are essential to the perfection of the grain or seed. In the first stage of its growth the starch of the seed is transformed into gum, and then sugar; in its second stage, when the leaves are expanded, the starch is transformed into woody fiber.

FROM THE FLOWER TO THE RIPENING OF THE FRUIT.

The sap has now become sweet and milky, indicating sugar and starch. These during the third period are gradually transformed in the sap into starch, a process exactly the reverse, or contrary of that in the first and second periods. The opening of the flower from the swollen bud is the first step taken by the plant to produce the seed by which its species is to be per-

petuated. At this period a new series of chemical changes commence in the plant.

1. The flower leaves absorb oxygen and emit carbonic acid all the time, both by day and by night.

2. They also emit pure nitrogen gas.

3. The juices of the plant cease to be sweet, even in the maple, sugar cane, and beet; the sugar becomes less abundant when the plant has begun to blossom. A change not difficult to understand when it is considered that nature is at work preparing to perfect the seed or fruit, and is not working for commercial interests. The structure of the plant is now of no consequence, and ceases to be of any importance. The imbibing of oxygen, which is the parent of all acids, is intended to convert the sugar into material for the seed, or fruit, the wheat or the peach, the strawberry or the squash.

The husk of grain bearing grasses, corn, wheat, oats, etc., is filled at first with a milky fluid which becomes gradually sweeter and more dense, or thicker, and finally consolidates into a mixture of starch and gluten, such as may be extracted from the grain as has already been said.

The fleshy envelopes of many plants, at first, tasteless, become sour and finally sweet, except in the lime, lemon and tamarind, in which the acid remains sensible to the taste when the seed has become perfectly ripe.

Fruits, when green, act upon the air like green leaves and twigs, that is, they imbibe oxygen and give off carbonic acid, but as they approach maturity they also absorb or retain oxygen gas. The same absorption of oxygen takes place when unripe fruits are plucked and left to ripen in the air, as is common in the case of tomatoes, oranges, lemons, and bananas. After a time, however, they begin throwing off carbonic acid and then they ferment, spoil or rot.

RIPENING OF THE FRUIT.

In the case of pulpy fruits, such as the grape, lemon, orange, apple, peach, plum, etc., when unripe and tasteless, they consist of the same substances as the leaf, a woody fiber filled with tasteless sap, and tinged with the green coloring matter of the plant. For a time, the young fruit performs the functions of the leaf, that is, it absorbs carbonic acid and gives off oxygen, thus extracting from the atmosphere a portion of the food by which its growth is promoted and its size is gradually increased. Remember what has been heretofore said about carbon constituting the bulk of the plant.

By and by, however, the fruit becomes sour to the taste, and this sourness rapidly increases, while at the same time it gives less oxygen than before, the retaining of the oxygen being, as has been said, the cause of the sourness, the oxygen converting the sugar into tartaric acid and water. The grape is an illustration, though the same thing happens in fruits abounding in the other vegetable acids.

This formation of acid proceeds for a certain time, the fruit becoming sourer and sourer. Then the sharp sourness begins to diminish, sugar is formed, and the fruit ripens. The acid, however, rarely disappears entirely, even in the sweetest fruits, until they begin to decay.

During the ripening of the fruit, the woody or cellular fiber gradually diminishes and is converted into sugar. This will be noticed in several kinds of fruits, particularly winter pears, which are uneatable when actually ripened on the tree, but become ripe, long after plucking, by continuing to absorb oxygen, which converts the woody fiber, or cellular tissue, into sugar, which is not difficult to understand, as woody fiber is very similar to sugar in its chemical constitution.

It should be noted that the entire forces of the plant are concentrated upon the seed, the element, or agent of reproduction, the pulp of the most delicious fruit, the kernel of the sweetest nut being nothing but protective envelopes and food supplies for the germ when the time and opportunity shall arrive for germination. So that the object of the plant in making so many transformations is not fruit, but seed.

FROM THE FALL OF THE LEAF TO THE FOLLOWING SPRING.

When the seed is fully ripe the functions of annual plants are ended. There is no longer any necessity for absorbing and decomposing carbonic acid; the leaves, therefore, begin to take in only oxygen, with the result that they are burned up, so to speak, and they become yellow, or parti-colored; the roots decline to take in any more food from the soil, and the whole plant prepares for its death and its burial in the soil by becoming resolved into the organic and inorganic elements from which it sprang, and of which it was originally compounded.

But of trees and perennial plants, a further labor is required. The ripened seed having been disposed of, there are incipient young buds to be provided for, buds which are to shoot out from the stem and branches on the ensuing spring. These buds are so many young plants for which a store of food must be laid away in the inner bark of the tree, or in the wood of the shrub itself.

The sap continues to flow rapidly until the leaves wither and fall, and then the food of the plant is converted partly into woody fiber and partly into starch. It has been shown how these substances are converted into food by chemical changes, or transformations, and these changes do not cease so long as the sap continues to move. Even in the depth of winter the sap slowly and secretly stores up starchy matter, in readiness, like the starch in the seed, to furnish food to the young buds when they shall awaken in the spring from their winter sleep. It is the same process as in the case of a seed planted in the ground.

RAPIDITY OF GROWTH.

It has been shown that from carbonic acid and water, the plant can extract all the elements of which its most bulky parts consist, and can build them up in numerous ways. But the rapidity with which the plant can perform this building up is almost incredible.

Wheat will shoot up several inches in three days, barley six inches in that time, and a vine twig will grow about two feet in three days. Cucumbers have been known to attain a length of twenty-four inches in six days, and a bamboo has increased its height nine feet in less than thirty days.

The rapid growth of vegetation in semi-tropical arid and semi-arid regions is phenomenal. A young eucalyptus tree has been known to grow thirty feet in a single season, and wheat or barley three inches high three days after planting is not uncommon. Potatoes (solanum tuberosum) have run up to fifteen pounds in weight before the plant had time to blossom, in fact, it never did blossom.

(To Be Continued.)

A GLIMPSE OF THE "LAND OF PROMISE"

A STORY OF IRRIGATION
In the
Celebrated Payette Valley, Southwestern Idaho

[By Our Special Correspondent]

The children of Israel spent forty years in the desert before entering the "promised land," but modern irrigation has transformed the desert into the "land of promise" in a single decade.

The settlement of our western arid states, as portrayed in early history, was a story of privation and loneliness. Much of this was not from necessity, but from the lack of proper colonization methods, the absence of united effort in establishing communities where the social conditions surrounding the settler in his new home might be equally pleasant with those of the older settled communities from which he came.

It was with this idea uppermost that in September, 1894, William E. Smythe, then chairman of the Executive Committee of the National Irrigation Congress, assisted in founding the New Plymouth Colony, in the now celebrated Payette Valley, in southwestern Idaho.

The history of this settlement demonstrated much more than its founders anticipated, and the sequel may be read with equal interest by capitalist and homeseeker.

After examining a number of locations in the western states, the Payette Valley was finally chosen, on account of its abundant water supply, fertile soil and genial climate; it being well understood by the leaders that in such an irrigated district the possibilities of intensified farming presented opportunities for smaller farms, greater profits, nearer neighbors, and many social advantages not to be found elsewhere.

THE FIRST SETTLERS.

The first settlement consisted of representatives of thirty-four families, many of them mechanics and professional men from the city of Chicago, with limited means and a still more limited knowledge of practical farming or fruit growing. Set down at the end of a long and tiresome journey in the midst of a sage-brush desert, without a house or cultivated field in sight, the weak dependent upon the strong for counsel and material aid, *the beginning* seemed *the end;* and but for the inspiration of numbers, several would have at once returned to the weary grind of city life.

A GROUP OF PROMISES.
(Bartlett Pear.)

No sooner had this little company of homeseekers filed upon desert entries and homesteads, than other and greater difficulties confronted them. Their land, valueless and unproductive without water, must be irrigated.

It was supposed by all that ample provision had been made for this. Eastern capitalists had built one of the best constructed canals in the State, with an abundant and never-failing water supply, taken from the beautiful Payette river, at the upper end of the valley. With this life-giving stream at their very doors—easily accessible through the lateral ditches, made by the farmers, from the main canal where it girded the foothills like a silver belt, running down over the gentle slopes in small streams, across the entire plain, where the unused portion, or "waste water," gradually wended its way back into the river, after imparting new life to the thirsty soil—what more could be desired?

THEIR "OPPORTUNITY."

Here was certainly a magnificent opportunity for the co-operation of capital and labor—$400,000 invested by eastern capitalists in the canal, 30,000 acres of choice sage brush land ready for immediate development by the throng of western homeseekers. There were "*millions in it;*" but lack of proper knowledge on the part of the Wall street financiers, who owned the canal, with regard to the necessities of an irrigated district and the management of such a canal, coupled with the inexperience of the settlers as to the proper use of water, was for a time equally disastrous to both parties.

The canal was bonded for $500,000. The farmer was required to pay $10 per acre, or give one-half his land, for the right to use water from the canal, in addition to which he was charged $1.50 per acre, each year, for not to exceed one-third of an inch of water (miners' inches), whether the same was used or not, and an additional charge at the same proportionate rate if more than one-third of an

PAYETTE VALLEY VIEW.

1. Birds-eye view of Payette, Idaho. 2. Beautiful Payette River. 3. Payette Valley alfalfa.

Had the 30,000 acres of land all been taken promptly by settlers under such a contract, there would certainly have been "millions in it" for the Canal Company.

Few, however, except the original unsuspecting entrymen, had the desire or nerve to enter into such a contract, and the "goose" which was expected to "lay the golden egg" to pay the interest on the $500,000 worth of "watered" bonds and the running expenses of the whole canal, found itself entirely inadequate to the occasion, and in many instances abandoned its nest and refused to lay another egg.

This was most disastrous for the Canal Company and bondholders and a period of seven "lean years" (especially for the bondholders) ensued. During the year 1900 the climax was reached; patience had ceased to be a virtue; all parties were anxious for a change. The old settlers, some of whom had made themselves comfortable homes in spite of all difficulties, and many new homeseekers who were willing to join them decided to purchase the canal, which the New York owners by this time were only too glad to sell at a great sacrifice.

A proposition for the reorganization of the new Plymouth Colony was presented by C. E. Brainard, of Payette, one of the oldest and most successful colonization agents on the Oregon Short Line Railway, and the purchase of the canal by the farmers; the sale and rapid development of the thousands of acres of sage brush land in the Payette Valley, during the past three years, is largely due to his energy, practical colonization ideas and good business judgment.

During the past two years the canal has undergone great and lasting improvements. Its extensive wooden flumes, over a mile in length, no longer safe on account of decay, have all been removed, and the great stream of water, equal to a river of no small volume, now follows the contour of the foothills, in a substantial and permanent earth canal. The mammoth wooden head-gates at the mouth of the canal, where it taps the main river, have now been replaced by massive stone and concrete gates of modern construction. The canal is managed by a competent Board of Directors elected by the farmers. Capital and labor are now working in harmony; *the laborers are the capitalists.* The farmers own the canal.

THE MIGHTY CHANGES.

In taking a retrospective view of the fall and rapid rise of this now most prosperous and envied settlement, with its attractive little town of New Plymouth as the center, surrounded by hundreds of beautiful and productive farms and fruit orchards, it is very difficult for the inexperienced to understand the cause of so sudden a transition, and quite as difficult for the experienced to realize how Wall street magnates could have made such an erroneous computation of the effects of reciprocity.

AN IRRIGATION SYSTEM IN OPERATION.

To the settler who now comes from the east or middle western states, the long and tiresome ride through the apparently endless vista of arid sage brush plain, traversed by the railroads now reaching the fertile valleys of southwestern Idaho, often created a genuine case of homesickness, and hundreds of those who start out with through tickets to the western coast, intending to "stop off" en route, close their eyes long before reaching the Payette Valley, in order that they may, if possible, shut out the depressing vision of the monotonous sea of somber sage brush for one little glimpse of the green sward of the old home still lingering in their mind's eye.

The traveler who simply passes through Idaho will certainly fail to see wherein lies its future greatness, nor is he likely to be impressed with the magnitude of its rapid development in the past few years. There is little of interest to be seen from the car window even by one who is wide awake and ever alert to behold evidences

of the wonderful resource of the Gem State, and the prospective homeseeker while passing through the undeveloped portion of the State has often been heard to exclaim, "I would not exchange my quarter section back home for the whole State of Idaho." Thus it is that one may be "so near and yet so far" from the realization of fondest hopes.

In order to see the beautiful and sequestered Payette Valley it is necessary to leave the train at Payette and traverse the valley for several miles up and down th river. Here the desert, which first greeted the early settlers and dissuaded many of them from grasping the riches lurking in the rich and productive soil beneath its mantle of sage brush, has almost disappeared, and in its place there are now hundreds of modern homes of prosperous, up-to-date farmers and fruit growers, beautiful green fields of alfalfa, clover and the everchanging shades of waving grain and blooming orchards. There are also numerous five and ten-acre tracts covered with melons, the celebrated Payette Valley cantaloupes, and other products of the truck gardens, from which many a home is supplied with all its necessities and even luxuries.

Fruit Pickers, Payette Valley, Idaho.
Payette Valley Orchard—8 years old.

Corn Field near Payette Valley.
Alfalfa Hay, Payette Valley—9 tons per acre.

WONDERFUL FRUIT PRODUCTIONS.

Idaho received the first prize for her apples at the World's Fair three times in succession, and at the National Irrigation Congress, held at Ogden, Utah, in September, 1903, won the $500 loving cup offered by Senator W. A. Clark "for the best display of the greatest number of varieties of perfect fruit, free from insect pests and fungus diseases." A finer or more complete display of fruit has never been seen at any of the world's fairs or expositions than was exhibited at Ogden from the irrigated States, and the Payette Valley may be justly proud of the fact that to her is given the greatest credit for the capture of this much-coveted trophy. The following dispatch was sent by President T. C. Galloway, of the State Horticultural Society, to his home paper, the Weiser *Signal:* "Idaho won the prize for fruit exhibit. All credit to the fruit growers of Payette." Signed, "Galloway." In an interview reported in the Boise *Statesman*, A. McPherson, State Horticultural Inspector, said, "To Payette Valley belongs the credit of winning the prize."

We quote a few editorial comments on this contest. The Payette *Independent* says:

A striking feature of the Idaho display met the eye immediately upon entering the exposition building. It was labeled "Before and After" and consisted of a huge sage bush over seven feet high, from Bingham county, placed directly over the big double rack of Payette Valley apples, with a plate of immense specimens of the fruit along side, some of them weighing twenty-four ounces, furnishing a striking commentary upon what can be done with Idaho land where irrigation is used.

The following classes and varieties of fruit are those that won the prize:

APPLES.

Jonathan, Ben Davis, Rome Beauty, Blue Parmain, White Winter Parmain, Wolf River, Red Beltighemer, Maiden Blush, Hubbard Nonesuch, Spitzenberg, R. I. Greening, Wagner, 20-ounce Pippin, Pewaukee, English Golden Russet, Arkansaw Black, Gano, Wealthy, Alexander, N. W. Greening, McMahan's White, Grimes' Golden, Buckenhan, Mann, Hyde's King of the West, Northern Spy, Yellow Bellflower, Gravenstein, Lady Heniker, Talman Sweet, Stark, Minkler, St. Lawrence,

Winesap, Fall Orange, Mammoth Black Twig, York Imperial, Delaware Red, Steel's Red Winter, Jeffrey, Duchess of Oldenberg, Yellow Transparent, Pride of Idaho, Minnatanka, Smith Cider, Cole's Quince, Geniton, Good Peasant, Missouri Pippin, Wandering Spy, Hass, Longfield, Cooper's Early White, Stebern's Seedling.

PRUNES.

Silver, Pacific, French, Hungarian, Tennant, Gold, Duane, Bulgarian.

PLUMS.

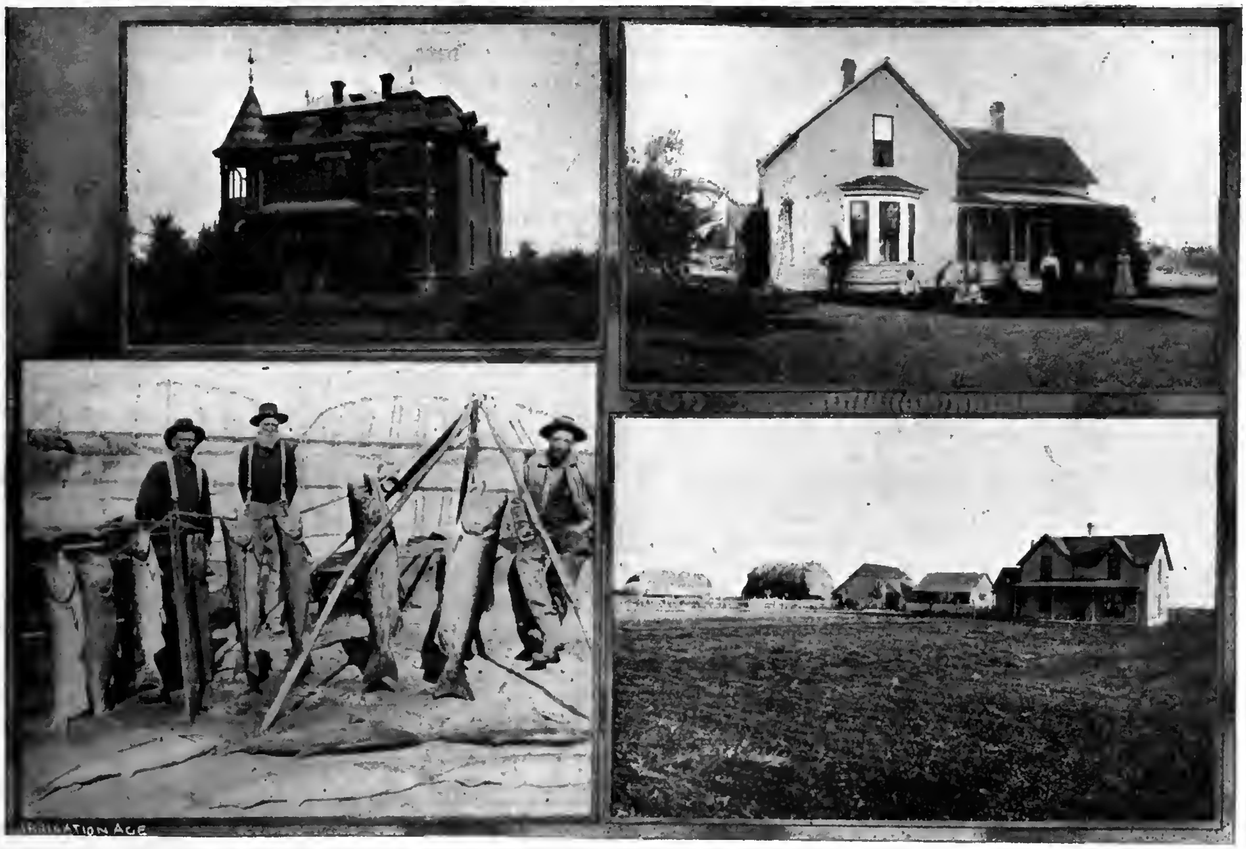
Burbank, Golden, Orient, Bradshaw, Lumbard, Greengage, Columbian, Blue Damson, Union Purple, Yellow Egg.

CRABS.

Transcendent, Hyslop, Martha, Whitney No. 20.

PEACHES.

Elberta, Champion, Early Crawford, Orange Cling, Prince Alexander, Late Crawford, Charlotte, Foster, Wager.



A Haodsome Payette Valley Home.
Fishing Grounds near Payette, Idaho.

A Comfortable Home in the Payette Valley.
Home of Manager of Farmers Canal near New Plymouth, Idaho.

PEARS.

Bartlett, Flemish Beauty, Buerre D'Anjou, Duchess D'Anjou, Buerre Easter, Patrick Parry, Idaho, Winter Nellis, Clapp's Favorite, Rodney, Wicker of Winfield, Erwin Seedling, Buerre Claigeau, Keifers, Seckle, Leconte, Comet, Sheldon, Lawrence.

GRAPES.

Fifteen varieties.
Jesse Strawberries.
Almonds.
Black Walnuts.

The expression so often heard, "The famous Payette Valley," seemed to be on everybody's lips after the award was made and the expression from all gave good ground for the belief that they had previously formed a most favorable opinion of this splendid section of Idaho, an opinion which was mightily strengthened by the new honor won.

Salt Lake Herald.—The *Herald* congratulates the Gem State on its fruit pre-eminence. We have no disposition to question the decision of the judges. They acted wisely and fairly and properly. The cup was won honestly and it was thoroughly deserved. And while, of course, the *Herald* regrets that the prize did not fall to Utah, at the same time it gives our fruit growers an object lesson they could have obtained in no other manner.

Salt Lake Tribune.—That was a noble fruit exhibit in connection with the Eleventh Irrigation Congress. It was pronounced by all to be the best they ever saw. The representative of California, Mr. Post, is reported to have said that in his fifteen years' experience in fruit exhibits he never saw anything like it. The sight was surely a superb one, and it was displayed to grand advantage. Idaho took the prize, winning the cup. It was a great honor, and it was worthily won. It was a showing worthy of the great occasion. In fact, all the States had shows that were ravishing to the sight. We congratulate our northern neighbor on her triumph, and concede that it was her due.

Deseret News, Salt Lake.—Since the valuable prize for the best fruit exhibit at the Irrigation Congress could not go to Utah, we are all glad that Idaho was the winner of it. The fact proves all the same the adaptability of the intermountain States for fruit raising, and the victory of our neighbor is a triumph for the entire region. Like the America's cup, Idaho's cup ought to be kept, to be competed for at intervals. It would then be of permanent value to horticulture, inasmuch as all interested would strive to remedy defects, and raise the very best fruit possible.

FACTS AND ITEMS OF INTEREST.

George H. Champ, president of the Utah Mortgage Loan Corporation, one of the leading loan companies investing in Idaho securities, in a recent official report sent out to eastern capitalists, includes the following interesting facts regarding the Payette Valley:

The New Plymouth Land & Colonization Company sold during the year 1902 to settlers, principally from Iowa, Illinois and Nebraska, coming into the valley, seventy-seven tracts under this canal. Considerations of sales \$133,667, of which \$50,520 was paid in cash.

EPISCOPAL CHURCH.

All of the land under the canal of the Farmers' Co-operative Irrigation Company, Limited, is of extra quality and of luxuriant fertility, and a large part of the whole district is highly improved and the balance is rapidly filling up with a prosperous class of farmers and fruit raisers. The location is very choice, indeed, and I can say that it is one of the finest farming districts I have ever looked over. The elevation is about 2,000 feet above sea level, the climate very mild and the summers are long and warm. The sun shines on an average two-thirds of the time. The valley has never been visited by hail storms or destructive winds, and but little rain if any, falls between June and September, thereby rendering the harvesting of crops safe and easy.

The unusually fortunate combination of climate, soil and moisture conditions, and the abundance of water supply for irrigation, places the Payette Valley in the very front rank agriculturally, including fruit growing.

The Payette Valley occupies the same position today to the State of Idaho as Cache Valley does to the State of Utah, viz.: the largest area of highly fertile and productive agricultural land, and a never failing water supply for the irrigation of same, populated by a thrifty, successful and substantial class of farmers. No matter of whom you may make inquiries as to the Payette Valley in Idaho the answer is, "The best locality in the State."

I. F. Roach, pastor of the First M. E. Church of Boise, after riding over the valley between Payette and New Plymouth, made the following comment in a letter to one of his friends:

I have never seen a section of land anywhere between Illinois and the Pacific Coast that has any greater promise of productiveness and beauty, when settled up and cultivated.

The topography is pleasant to the eye, and with the inexhaustible supply of water at the farmer's command, industry will certainly make a very desirable place for a home.

WHAT A PROMINENT PAYETTE VALLEY FRUIT GROWER SAYS.

In writing to a Kansas fruit grower last winter, Mr. N. A. Jacobsen, of Payette, one of the many wealthy fruit growers of that locality, wrote as follows:

In reply to your inquiry relative to my orchard here at Payette and what can reasonably be expected from a winter apple orchard in this Valley, would say that my trees from twelve to thirteen years old have yielded from fifteen to twenty boxes per tree (fifty pounds per box) and these have sold on track here at from 50 cents to $1.50 per box according to grade and the market price.

There are about eighty trees to the acre on an average.

Apple trees will begin bearing on the fourth or fifth year, according to variety.

My winter pears this season sold for $1.25 per box here and I received $645 net for this year's crop from seventy trees (about one acre) thirteen years old.

The soil and climate in this Valley are excellent for this class of fruit, and it will stand shipment to good advantage.

The color and flavor of apples raised in this Valley are especially fine.

Yours very truly,

Signed, N. A. JACOBSEN.

At the present writing, Mr. Jacobsen and his family are enjoying a holiday trip to Honolulu, while his agent collects the rents from several brick blocks and residences which he has erected in the thriving town of Payette, from the profits of his sixty-acre orchard.

FRUIT PACKING ASSOCIATIONS.

The fruit growers of Payette and vicinity organized and incorporated a fruit packing association in 1903 for the proper handling and packing of fruit for shipment. A commodious building was erected and very satisfactory results were realized from this year's pack. A similar organization was perfected at New Plymouth, at which point a first-class commercial fruit evaporating plant is owned and operated by the New Plymouth Fruit Association.

But the Payette Valley farmer does not confine his attention to the raising of fruit alone.

A recent correspondent of the *Pacific Northwest*, after riding through the Payette Valley, devotes several columns to unstinted praise. In one of his paragraphs he says:

Beginning at the upper end of this great wealth producing farm region, the traveler sees stacks of hay scattered generally over the entire Valley, that if placed end to end would reach from the eastern to the western end of the Valley in one continuous line of stacks, averaging sixty feet in length and over twenty-four feet in width.

The stranger passing through on the Oregon Short Line Railway, which crosses the valley of the Payette River at its confluence with Snake River, might wonder where a market for all this staple product could be found, but when it is known that approximately a quarter of a million sheep find feeding grounds in the Valley each and every winter, and that the thousands of head of cattle and horses that graze in the summer time upon the unlimited government range make their winter homes near the farmer's hay stacks, there is no longer any mystery about it.

TELEPHONES AND RURAL DELIVERY.

The telephone lines of the "Bell" and "Independent" systems, with long distance connections, are already in universal use in the towns of Payette and New

CHRISTIAN CHURCH.

CATHOLIC CHURCH.

Plymouth and the thickly settled farming district between these towns.

The Independent Company has the best of modern equipment and is owned and operated by Payette Valley people exclusively. It is being extended all over the farming community as rapidly as new lines can be built, and is giving entire satisfaction.

This, with the recent rural mail routes established throughout the valley, gives the settler the best business and social advantages to be found in any farming community, and the present settlers are in full accord with the President's message where he says: "We can not have too much immigration of the right kind, and we should have none at all of the wrong kind."

PAYETTE CITY.

This thriving and prosperous little city has a population of about 2,000. It has been the principal shipping station of the Payette Valley since the completion of the Oregon Short Line Railway in 1883. During the present year it has secured a city charter and is having a very rapid but substantial growth. Brick blocks and elegant residences are in evidence on all the principal streets. It is already one of the busiest little cities in the State. The deposits in its two banks are more than half a million dollars. Its business men are enterprising and industrious, and most of them own their own buildings.

IMPROVEMENTS.

An electric light plant is now in operation and water works and sewerage are to be added. In many respects it is is an ideal place for a home. Its graded public and high school is of the best in the State, occupying two commodious brick buildings, supplied with two commodious brick buildings, supplied with modern equipment and accommodating over 600 pupils now enrolled.

Payette is a city of churches, eight denominations having buildings of their own, all except the Episcopal and Catholic having resident pastors.

A free library association has recently been organized, with gymnasium equipment, games and rest room. There is a number of benevolent and secret societies, including three Masonic lodges, Odd Fellows, Rebeccas, Modern Woodmen of America of over 200 members, Royal Neighbors, and several other fraternal organizations; also a good musical society.

Several parties interested in the beet sugar industry do not hesitate to say that Payette is one of the best locations in the State for a sugar factory, and if the bounty now offered by the State is found to be constitutional, arrangements for such a factory will be completed in 1904 without a doubt.

Two large saw mills are in active operation, having a capacity of over 100,000 feet of lumber per day. The logs are floated down the Payette river for over 100 miles from the almost inexhaustible supply of timber in the mountains near its head waters. Two planing mills and a box factory are heavy consumers of the raw material.

A creamery has been in operation for several years, receiving the highest prize at the State Fair, and in 1903 a first-class canning factory was built and equipped with modern machinery, and much of its pack is consumed in the great copper mining camps of the Seven Devils Range, which can be seen in the distance from Payette. and from which its brand "Seven Devils" is derived.

A full roller process flour mill of fifty barrels per day capacity is operated by water power.

A power company has recently been organized to utilize the waters of the Payette river for manufacturing purposes, electric lights and operating an interurban railway, which will soon be built to connect Payette with New Plymouth, Emmett and the Pearl mining camp. This line will connect with the Oregon Short Line Railway at Payette and will be of standard gauge, equipped to handle freight and express as well as passenger business. The demand for such a road has recently become very urgent on account of the large orchards, now in full bearing in all parts of the valley, and the greatly increased population of the surrounding farming district. Local parties are now negotiating for eastern capital, and with the great volume of business

PRESBYTERIAN CHURCH.

in sight there should be no trouble in financing this proposition without much delay.

ADVANTAGES.

An excellent vein of soft coal has recently been opened at the upper end of the Payette Valley, not far from the rapidly developing gold mining camp of Pearl, and with proper railroad facilities these mines should increase their present output many times during the first year. The wool shipments from this vicinity, which amounts to from fifty to seventy-five cars annually, represent a net profit of from $35,000 to $50,000 for our wool growers. The thousands of acres of free range in the surrounding mountainous country is open to all, and this industry will be largely increased rom year to year as the valley becomes more thickly populated.

This is an excellent working field for the masses. People with limited means can soon make themselves comfortable homes here and enjoy the fruits of their labors while they live. The field is equally good for the capitalist, and people with from $1,000 to $50,000 can not find a better locality in the West for safe and profitable investment.

OFFICE OF NEW PLYMOUTH LAND & COLONIZATION CO., Ltd., BANK OF COMMERCE & FIRST NATIONAL BANK.

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THE IRRIGATION AGE

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SPECIAL FEATURES

CHARLES A. COX CHGO.

THE IRRIGATION AGE

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

Increase in Value. It is gratifying to know that the beet sugar growers of Nebraska are to receive for their beets this year more than last. Contracts with the American Beet Sugar Company for the season of 1904 have just been signed at a price of $4.50 per ton for all beets, regardless of the per cent of sugar which they contain. An additional sum of 25 cents per ton is allowed for hauling to the factories, making a flat price of $4.75 per ton. The price last year was $4.00, and the average price for the past ten years has been $4.20 per ton. Beet growers in the irrigated portion of Nebraska will profit most as their crops are generally conceded to be of better quality. The possibility of beet culture in the irrigated districts is greater than ever before, and the increase in this industry during the next few years will be enormous.

Newspapers "Worked." The land law repealers, through their elaborate press bureau, which is maintained by a few of the powerful corporations of the West, are working a very smooth game upon the newspapers of the country. This press bureau sends out weekly syndicate matter alleged to be news correspondence from Washington, all of which contains a cleverly disguised plea for the repeal of the commutation clause of the homestead act, the timber and stone act, and the desert land law. Several newspapers have printed this matter, doubtless without careful investigation or even knowledge of the real nigger in the wood pile, and the repealers are now quoting these extracts from the newspapers as editorial expressions by them. They are printed by the thousands and sent to every newspaper in the country in the hope of influencing that portion of the press which has not as yet taken up their side of the question. It is a very clever game, and the wonder is that newspaper men who are not easily taken in have been fooled by it.

Yakima Valley. A large amount of work has been done on the Yakima Valley canal in Washington State during the past year. This canal was commenced in 1894, with the object of irrigating about 3,000 acres, but the plans of the canal company have been greatly enlarged and some valuable experience has been learned since the commencement of the work. The original canal, which was about eight miles long, has been rebuilt in many places. The settling of the foundation started leaks on several sections of the canal, and much of it was destroyed by the washing out of the ground underneath. The old flume under the new plans has been enlarged and the sills upon which the uprights for the foundation rest run parallel with the flume instead of transversely. The flume has been lined with liquid asphaltum, tar and ground lime, which was applied as a mixture while hot. It is believed that this treatment of the flume will prevent all further leakage. It has

cost canal companies hundreds of thousands of dollars to learn one of the most important items of construction—the necessity of the absolute waterproof character of flumes. The loss of water by leakage and the damage by seepage is enormous, and future canal builders will profit by the experience of the past.

Iowa Drainage Convention. The Iowa Drainage convention, whose sessions commenced at Ames, January 15, and continued several days, was one of the most important meetings in the interest of modern agricultural development that has been held during the past year. The convention was attended by a large number of the most intelligent farmers and land owners of Iowa, and among the visitors from other States were some of the most prominent drainage scientists of the country. Professor W. H. Stevenson's report of his investigation of the drainage conditions of Iowa is intensely interesting and quite significant in its character. He conducted this investigation in the most thorough manner, sending out carefully prepared questions to every part of the State, from which he received nearly 2,000 replies in detail. Of these replies, Professor Stevenson estimates that there are nearly four and a half millions of acres of nonproductive land in the State through lack of drainage, and that this land could be made to increase the wealth of the farmers by proper methods to the extent of 324 millions of dollars. The subject of drainage in the humid sections of the United States is now one of the most important problems that confronts progressive agriculturists, and when the people thoroughly understand its benefits the increased wealth of the country will be almost beyond computation.

Curious Procedure. A very curious procedure is that of the publication of the official proceedings of the Eleventh National Irrigation Congress at Ogden under the management of Gilbert McClurg and Willis T. Beardsley. When the congress adjourned at Ogden last summer, the local committee of that city undertook the publication of the proceedings and it was understood that copies would be supplied to the members of the Congress without cost. Now Messrs. McClurg & Beardsley have issued a circular announcing that the proceedings are being published by the Proceedings Publishing Company, of Ogden, and that the price of $1 per copy in paper and $2 per copy in leather has been placed on the work. In addition to this source of income these gentlemen are asking advertisers to take space in this pamphlet at the rate of $50 per page. As the total cost of publishing these proceedings does not exceed $200—in fact, this price was named as a total cost during the convention—the Proceedings Publishing Company, which is doubtless composed of Mr. Gilbert McClurg and Willis T. Beardsley, will make an exceedingly good profit out of it. It would seem that the National Irrigation Congress is a body of sufficient strength and dignity to publish its own proceedings for free distribution, at least among the delegates, and without resorting to the cheap claptrap methods employed by these gentlemen. The officials of the congress will doubtless be surprised when they discover that the name of the congress is being used in this manner to further the interests of an advertising project solely for the benefit of its promoters. Delegates to the congress are being asked to contribute from ten to twenty dollars apiece for the privilege of having their photos appear in connection with this report.

Combination of Interests. The combination of interests which opposed the passage of the national irrigation law by every means in its power, but which has now assumed the general direction of the whole irrigation business of the Government, is sending out through its news bureau bitter personal attacks upon Senator Hansbrough of North Dakota, because he has introduced a bill providing for the appointment of a chief engineer to superintend the construction of irrigation works. These self-constituted bosses of the Government's business have boasted privately that they control to a large degree the reclamation service, and it is only natural that they do not want any officer appointed to interfere with their plans. They assert that Mr. Newell is the most competent engineer in the United States, and is the only man who ought to have charge of the vast expenditures of Government money incident to the irrigation act. But the record of Mr. Newell's achievements tell a different story. Personally a most estimable gentleman, and above all reproach as a private citizen, he has not done anything in the line of his profession, which has fitted him by education or experience as an engineer for the trying duties of his great position. His appointment to the Government's service was brought about through a political and business combination, and it is well known that he owes his position mainly to the forces that are now attempting to control the reclamation service. Senator Hansbrough's precaution in asking for the appointment of an engineer of undoubted ability and experience to take charge of the vast projects which the Government is expected to carry out within the next twenty years is a wise one, and intended solely to safeguard the interests of the people. The only objection to this appointment that is made by the corporate interests is that Mr. Newell should be allowed to work out their plans without interference. But that is the best reason in the world why the appointment of an engineer, as provided in the bill of Mr. Hansbrough, should be made. Judging from the sentiment of Congress, as privately expressed by many members to THE IRRIGATHON AGE, it looks as

though the combination would fail to defeat Senator Hansbrough's bill, and that a competent engineer will be appointed to superintend the Government's plans and see that the vast sums of money for this purpose are wisely expended.

Are the Repealers Fair?

The interests that are so frantically demanding the repeal of the commutation clause of the homestead, the desert land and the timber and stone land laws for the benefit of "future generations" base their demands mainly upon the alleged frauds that have been committed against the government in the past. They assert that unscrupulous individuals and corporations have gobbled large tracts of valuable Government timber and mineral lands through hired agents who made bogus entries upon them and afterwards turned over their holdings to the land grabbers who employed them. On account of these frauds the repealers demand that the Government withdraw from entry millions of acres of lands that are available for settlers under terms which, in the wisdom of Congress, are fair, equitable and easy to carry out.

There is no doubt that many frauds have been perpetrated by unscrupulous corporations and individuals, although the repealers have never yet given any definite figures as to the extent of these frauds. They have contented themselves with statements that are general and broad in character, and do not attempt to give any definite information on that subject. But, admitting that frauds have been committed in this manner, is there any good reason why the honest settler of today should suffer through the negligence of Government employees in allowing these frauds to be perpetrated? And is it not a fact that many of the unscrupulous corporations having secured titles to tracts of land in this manner are now endeavoring to arrange a scheme by which they can still further profit by forcing settlers to buy these lands from them? This can only be accomplished by taking out of the reach of the settler the Government land that is not occupied. If the commutation clause of the Homestead Act and other laws are repealed the only way that the honest settler can obtain lands from the Government is by the general Homestead Act, which requires five years' actual residence on the wild lands.

With the desert land and the stone and timber lands withdrawn from settlement, the settler would have to make his choice between living five years on a piece of land before he could obtain title to it and the purchase of land outright. As the railroad companies and a few large land combinations would then own all the available lands, aside from those subject to the Homestead law, the settler would be forced to buy from them. And this fact points to the secret of the gigantic combination that is working so powerfully for the repeal of the land laws.

The millions of acres owned by the railroads and corporations are now nonproductive. If these lands can be sold to settlers, even on long time and easy terms, they at once become interest-bearing, and thereby revenue-producing, and the railroad and private companies, instead of being compelled to pay the taxes themselves, shift the burden to the farmer, and he becomes the tax payer and interest payer from the day he signs the contract. Does anybody believe that the repealers, who are maintaining newspapers and literary bureaus at the cost of thousands of dollars every month, and sending speakers all over the country to argue with boards of trade and merchants' associations, are doing this in the interest of "future generations" or anybody else except themselves? Does anybody know of a syndicate or private land corporation that ever worked hard and spent its money for the benefit of generations, or anybody on earth, present or future, except itself? Not at all. These interests are simply trying to throw dust in the eyes of the people by pretending to be concerned about the future welfare of the people, while they are in reality only trying to prevent the settler of today from obtaining a home from the Government and forcing him to relieve them of the taxes on their own lands and pay them interest besides. The fact that the public is rapidly finding out the true state of affairs, and the widespread interest that is being aroused in the schemes of the gigantic combination of repealers, gives rise to the hope that their plans will be defeated. In view of all the revelations that are now being made, the repealers would have acted more wisely if in their attitude toward the people had they waged this war on the only grounds tenable to themselves—self-interest and a desire to grab all there is in sight.

Needlessly Alarmed.

The board of lonely, disinterested philanthropic gentlemen who are vigorously working for a repeal of the commutation clause of the homestead law, the timber and stone act and the desert land law, express the most alarming solicitude for the generation of future farmers who will not have a place left on this part of the globe upon which to establish a home. It may be of interest to these gentlemen to know what the authorities of the agricultural department of Washington think of the future possibilities of free land in this country. Milton Whitney, Chief of the Division of the Bureau of Soils of the Agricultural Department, who has been for years conducting a series of soil surveys in nearly every State in the Union and who is probably better acquainted with the agricultural land possibilities of the West than any other man in the United States, said to a representative of THE IRRIGATION AGE a few weeks ago:

"If all of the Government land west of the Missouri River should be withdrawn from settlement today, there still would be room enough left for all the

farmers of America for the next one hundred years. They would all have land enough to support their families and grow rich. Modern science in agriculture has taught men how to reclaim the worn-out lands of the South and the East and there are millions of acres that are now supposed to be unproductive that can be made to blossom as the rose by the application of proper methods of farming and fertilization."

In making this statement Professor Whitney was not discussing the possibilities of the irrigation law, but was simply pointing out the tremendous possibilities of the older portions of the United States, which many people think have been exhausted by fifty to one hundred years of continual cropping. If Professor Whitney's statement is based on a foundation of fact, and we think even the repealers will not dispute that, these gentlemen are wasting a great deal of sympathy on the unborn generations in their efforts to take from public settlement the hundreds of thousands of acres that are now opened to them under the Government laws and force them to buy their homes from the syndicate land combinations.

The Honorable Frank W. Mondell, Representative from Wyoming, in his speech in Congress on the bill for the relief of certain homestead settlers in Alabama, discussed this question at length and presented figures to show that the increase in the number of original homestead entries during the past two years is more apparent than real. The increase in 1902 was due almost entirely to the vast area of former Indian lands entered in Oklahoma, amounting to nearly four and a half millions, and land in North Dakota of two and a half millions, and in Washington of about one million acres.

The undisputed facts are that these lands have been taken almost entirely by bona fide settlers and no considerable portion of them have found their way into the hands of the speculators or land combinations. The frauds in this respect are confined almost entirely to the valuable timber lands of the Rocky Mountain regions. The records show that during 1902 only one acre in five was commuted; at the same rate of commutation, if all the remaining public lands were so disposed of, it would take over five hundred years to absorb what is left of the public domain. However deplorable the frauds in timber lands, they can not be set up as a good reason why the honest settler should be deprived of the right to make his home in the West under present laws. Proper amendments to the laws will prevent fraud in settlement in the future, but that they should be entirely repealed is another question. Speaking of the desert land act Senator Warren, of Wyoming, whose long years of residence in the West and whose close study of the actual conditions existing there makes him a competent authority, says:

"Under this act more arid lands have been reclaimed, more barren wastes have been converted into growing fields of hay and grain, and more unproductive land has been made permanently productive than under any other law applicable to the Western country. No other law properly administered reduces to so much of minimum the opportunity for abuse and prevarication. Everywhere over the Western country the arid wastes are spotted by beautiful fields of growing grain and alfalfa, which testify beyond the possibilities of contradiction to the splendid and material results legitimately accomplished under the law."

With this clear statement of actual facts can any sane man doubt that the repeal of the desert land act would do more to delay the settlement and development of the West than any other thing that Congress has ever been asked to do?

PRIMER OF IRRIGATION.

[*Conclusion Chapter VIII. From December Issue.*]

Three-pound onions, eighty-pound watermelons, and five-hundred-pound squash are not rarities, and I have been told of a field of corn, of the white Mexican variety, that grew fourteen feet with four perfect ears of corn to the stalk with only twelve inches of rain. As for sweet potatoes, or yams, thirty pounds weight do not occasion surprise, and beets after two years' growth are often as large as nail kegs, all woody fiber, of course, and unfit for food.

It is true that such examples are mere experiments, indeed they may be called specimens of "freak" vegetation, and rarely mean perfection of quality, but they indicate the ability of the plant to rapidly assimilate from the soil and air large, even excessive, quantities of the elements it needs, or fancies, provided they exist in abundance, and they demonstrate that the farmer has it within his power to convert this enormous productive energy into "quality" of product by regulating it through adequacy of moisture and cultivation without excess.

In the foregoing chapters nothing but the mere outlines of the chemistry of agriculture have been given. Even to do that it was necessary to concentrate a mass of matter from a multitude of books, lectures, personal experiences of successful farmers, and from other sources, to reach simplicity and clearness. The books are full of never-ending disputes over theories, doctrines and scientific experiments, relating to plants and the soil, and it was thought best to eliminate all those disputes and present the operations of nature with regard to the soil and plants in as simple a manner as possible.

There are many things mysterious in nature which science has not yet been able to explain, and which practical experience accepts without inquiring into reasons or causes. Why do early potatoes often reach maturity and the vines die down before the latter have a chance to blossom? What is the answer to the problem of seedless fruits, such as oranges, lemons, grapes, etc.? Why do certain plants revert to originals which have few traits in common, like the tomato, for instance? Why do not the seeds of plants always produce the same variety? We know that the laws of chemistry are practically immutable, though their manifestations may be irregular. What has been written, it is hoped, will be of some benefit toward preparing for the practical part of this book, which will occupy the subsequent chapters.

REPEALERS IN DEEP WATER.

Organized and Active Lobby in Washington Spending Money But Accomplishing Little.

[SPECIAL CORRESPONDENCE IRRIGATION AGE.]

WASHINGTON, D. C., Jan. 10.—Hon. Frank W. Mondell, representative in Congress from Wyoming, in talking to a group of Congressmen at the Willard Hotel recently on the activity of the repealers' lobby in Washington, said:

"I am convinced that there is no crying need for a radical change in the land laws at this session of Congress. For the first time in our history we see an active and well-organized lobby in Washington supported almost entirely by contributions of great corporate landscrip owners. These unscrupulous fellows have been industriously and persistently magnifying every irregularity and local abuse of our land laws by sending broadcast the most grossly misleading and untruthful statements as to the volume and effect of the transfer of Government lands into the hands of private individuals.

"The most persistent of these representations is regarding the disposition of lands under the timber and stone act, the desert land act and the commutation clause of the homestead act. The acreage of lands disposed of under these acts the last few years has been grossly exaggerated. In the last five years the Government has parted title to only 8,683,090 acres of land under these laws.

"Another argument used by the lobbyists who, in the interest of large corporate holders of land and scrip, are desirous of having most of the public land laws repealed is based on the hypothesis that the present alleged rapid disposal of public lands will interfere with irrigation reclamation and particularly with the operations of the national irrigation act. This plea rather loses its force when they say that the desert land act is the only law compelling irrigation. It is admitted even by those who favor repeal that by it more lands have been irrigated than under all the other land laws combined. Inasmuch as lands taken under the timber and stone act are unfit for agriculture, there remain only the lands commuted under the homestead law within the arid region as the area which, accepting the most extreme statements of the repealers, passes from public into private ownership without being reclaimed.

HON. FRANK W. MONDELL.

Mr. Mondell, the representative from Wyoming in Congress, is chairman of the House Committee on Irrigation and in that capacity will be in a position to do good work for the service. He is one of the ablest young men in Congress, a tireless worker, and his long experience with the actual conditions in the arid West makes his appointment peculiarly fitting. He is very popular among the members of Congress, and his intelligent and successful work in the past in the interest of irrigation has given him a wide influence. Mr. Mondell is serving his fourth term in Congress. As a member of the Wyoming Senate for four years he took a large part in aiding in the perfection of the arid land law, which the Wyoming people believe to be the best in the land.

"At the present time approximately 25,000,000 acres of land are reserved under the national irrigation act, none of which can be entered according to the laws in question.

"In view of the undertaking by the reclamation service of the Salt River irrigation enterprises, covering land entirely in private ownership, as one of the first two projects inaugurated, it appears that those in charge of work under the national irrigation act do not consider that the passing of land into private ownership seriously interferes with undertakings under the act. The fact is that the three laws in question furnish nearly four-fifths of the entire reclamation fund and their repeal would mean the side tracking of the national irrigation law, after the $20,000,000 now in the treasury was exhausted. The desert land act properly administered is the best land law on the statute books. The final entries under it amounted to only 264,593 acres in the last year out of the estimated 50,000,000 acres of irrigable lands on the public domain. There can be no doubt that in some localities the law has been abused, but this is a matter for administrative, not legislative, action.

"The commutation clause of the homestead law is utilized to but a limited extent in the strictly arid

portions of the country. Its principal employment seems to have been in the semi-arid region where constant effort is being made to make more productive the lands which in their natural state are of but little value and which by reason of lack of water supply can not be irrigated. No law on the statute books has done more to encourage pioneers and home-builders than this. In my opinion the important question for consideration in connection with the timber and stone act is whether the Government is receiving a fair price for these lands. In the inter-mountain States, where timber lands are of small value, this law is of great benefit to the settlers and ranchmen, while enabling the Government to dispose of the lands of small value at a good price.

IN THE RECLAMATION SERVICE.

WASHINGTON, D. C., Jan. 15.—The following appointments and promotions in the engineering corps of the Reclamation Service are announced for January:

California.—Samuel G. Bennett, engineer, at $2,000, by promotion from same at $1,800; Homer Hamlin, engineer, at $2,200, by promotion from same at $2,000; Jacob C. Clausen, engineer, at $1,800, by promotion from assistant engineer at $1,600; Ernest R. Childs, assistant engineer, at $1,400, by promotion from engineering aid at $1,000; Charles E. Slonaker, observer, $900, by promotion from same at $840.

Colorado.—Joseph A. Sargent, assistant engineer, $1,600, by promotion from same at $1,400; Percival M. Churchill, assistant hydrographer, $1,600, by promotion from same at $1,400; E. E. Sands, assistant engineer, at $1,400, by promotion from same at $1,200; L. J. Charles, assistant engineer, at $1,200, by promotion from same at $900; Hugh G. Stoke, engineering aid, at $1,000, by promotion from same at $900; Ernest E. Bailey, engineering aid, at $840, by promotion from same at $720; Francis M. Madden, hydrographic aid, at $900, by promotion from engineering aid at $60 per month.

Washington.—Christian Anderson, engineer, at $1,800, by promotion from same at $1,500; George H. Bliss, assistant engineer, at $1,500, by promotion from same at $1,400; Charles E. Hewitt, engineering aid, at $1,000, by promotion from same at $75 per month.

Wyoming.—Lester V. Branch, assistant engineer, at $1,600, by promotion from irrigation engineer at $1,400.

Utah.—William D. Beers, assistant engineer, at $1,200, by promotion from engineer aid, $1,000; D. W. Hays, assistant engineer, at $1,400, by promotion from same at $1,200; Clyde V. Taylor, assistant engineer, at $1,400, by promotion from same at $1,200; August H. Schadler, engineering aid, at $900, by promotion from same at $720.

The gaging station maintained by the United States Geological Survey on the Big Sioux River at Watertown, S. D., has been ordered discontinued for the reason that data for same is of a value not commensurate with cost of maintenance.

A long delayed answer to "Housewife's" inquiry: "Which is the best way to cook a watermelon?" Having submitted the query to various cooking schools and daily paper cookery departments, without receiving any reply, we are obliged to confess that we don't know.

HISTORY OF PUMPING WATER.*

Wonderful Development of Plants for Irrigating Purposes and Their Use in New Mexico.

BY JOHN J. VERNON AND FRANCIS E. LESTER.
New Mexico College of Agriculture.

EQUIPMENT.

The derrick used consisted of a ladder, made of 3 by 8 inch pine, 22 feet long, with an extension piece 4 by 6 inches, 6 feet long, in the end of which was placed a pulley. Three $1\frac{1}{4}$ inch guy ropes were used to hold the derrick in position (see Fig. 2). Any form of derrick may be used, provided, of course, it is stable and of sufficient height to allow ample space between the end of the pipe and the pulley for the free play of the sand-bucket and drill.

Fig. 3. Common type of sand-bucket.

The sand-bucket used was of the piston or plunger type. (See Fig. 3.) This type of sand-bucket operates on the same principle as a suction pump, by simply letting the plunger to the bottom of the sand-bucket, raising it up and down a few times until sufficient sand and gravel is drawn by suction into the bucket with the water, raising the sand-bucket out from the well, emptying it, and lowering it again into the well. A cheap sand-bucket which will do satisfactory work may be made by any blacksmith, by putting a bail on the top, and a valve in the bottom, of an ordinary pipe. This pipe should be slightly smaller than the well pipe, and from 3 to 5 feet long. The length, however, may vary, but should be such as to be conveniently handled. (See Fig. 4.) With this type of sand-bucket, the whole bucket must be moved up and down in filling, requiring more work than the plunger type above described. It is, however, a lighter bucket, which compensates somewhat for the extra effort in filling. It is usually best to raise the sand-bucket up some distance, and allow it to drop, as by coming down with some force, the water and sand open the valve in the bottom and rush inside.

The drill used was simply a piece of steel half an inch thick, three inches wide, eighteen inches long, properly pointed and hardened. This was threaded so as to be attached to a $1\frac{1}{4}$-inch pipe, eighteen to twenty feet in length, in order to give it weight. A ring was fastened in the upper end of the pipe in which to tie the rope. (See Fig. 5.)

A $\frac{3}{4}$-inch rope 200 feet long was used on the sand-bucket and drill. In sinking a well, the length of the rope will depend upon the depth of the well, height of the derrick, whether or not a horse is used, and if so, whether the filling is done by a horse or by men. This, however, will be more fully explained in discussing the sinking of the well.

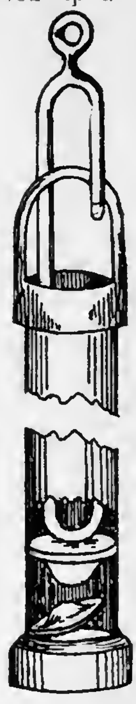


Fig. 4. Plunger type of sand-bucket used in sinking Station well.

Two sets of heavy wooden clamps

* From Bulletin No. 45 issued by the New Mexico College of Agriculture and Mechanic Arts, Mesilla Park, N. M.

were fastened upon the pipe with bolts to support the sacks of sand or other weights. (See Figs. 6 and 6½.)

From ten to sixteen sacks were filled with sand and used as weights for assisting in settling the pipe, and to insure that it keep pace with the sand-bucket during the sinking of the well. In the regular business of sinking wells of this character, heavy iron weights with rings attached would doubtless be preferable to sacks of sand, but for those contemplating the sinking of their own wells, the latter will prove entirely satisfactory.

Two heavy chain-pipe wrenches were used for connecting and disconnecting pipes, and for turning the well pipe while sinking.

Hammers, small wrenches, nails, rope, plank for platform, timbers for holding pipe perpendicular in starting, etc., completed the equipment.

Below is given a list of the materials used: Lumber for the curb: one length 21½ feet, standard black pipe six inches in diameter; one No. 16 gauge galvanized iron strainer, 14 feet long, perforation extending for 12 feet.

The curb was made 8 feet wide and 9 feet long from two-inch Texas pine. This size was necessary in order to facilitate the exchanging of pumps tested. In a private plant, however, the curb should be of a size to suit the pump to be installed. At the top of the curb a heavy timber, six by eight inches, extending 3 to 4 feet beyond each end of the curb, was securely bolted to each side in order to prevent the curb from settling. (Fig. 11 illustrates a good type of curbing.)

SINKING THE WELL.

With the station well, the open portion was dug, the pipe sunk, and the strainer placed, before the curb was put in place. This was found to be a mistake by reason of the fact that, owing to the splashing of water, etc., the soil caved in and much difficulty was encountered in placing the curb, necessitating an amount of extra digging before it could be satisfactorily accomplished.

Fig. 5. Drill used in sinking the Station well.

After the open portion of the well was dug, the location of the pipe was decided upon, and the derrick was then raised and placed in a slanting position in such a manner that the rope swung entirely clear, and fell upon the point selected for the pipe. The guy ropes were fastened to "dead men," consisting of eight-inch logs, laid about three feet in the ground, and the derrick securely anchored at its base to two posts set deep in the soil. A hole was dug as deep as possible where the pipe was to enter, and the latter was then put in position. Before placing the pipe, however, slanting teeth about an inch deep were cut in its lower end for the purpose of assisting in moving aside any gravel that might impede the progress of the pipe, or in order to cut through any hardpan that might be encountered. (See Fig. 7.) Care was taken to have the pipe perpendicular at the start, and timbers were placed on all four sides both at the top and bottom of the open portion of the well so as to keep it perfectly plumb until it had penetrated the earth to a distance of several feet. This is an important feature in well construction of this kind. Great care should be taken to keep the pipe perpendicular at all stages of the sinking of the well, as otherwise it may be out of plumb when the well is completed, causing consequent difficulty in properly connecting the pump.

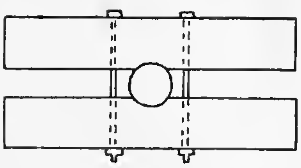


Fig. 6. Clamps used on well pipe during sinking to support weights; (top view).

Weights were placed and the sand-bucket was then brought into requisition. The pipe settled about 4 feet in five minutes. More weights were added as needed, and the pipe turned frequently with the large pipe wrenches. Frequent turning of the pipe was found to expedite its sinking. The pipe would often seem to be stuck, but upon giving it a few turns it would settle down several inches, and occasionally drop almost a foot at a time. It is probable that more weights and more frequent turning would have made the pipe precede the sand-bucket all the time. This would have been an advantage, inasmuch as during the sinking of the pipe the sand-bucket two or three times preceded it, so that the flange around the outside at its lower end became fastened under the end of the pipe, necessitating jacking up the latter before it could be extricated. With a common sand-bucket this difficulty would not have been encountered.

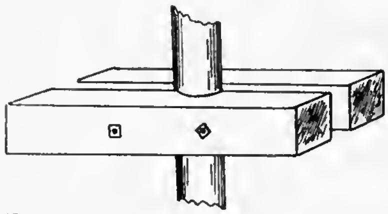


Fig. 6½. Side view of clamps shown in Fig. 6.

It requires three strong men to draw a well-filled sand-bucket out of the well, continuing the work from day to day. The work, however, may be done by a horse during the entire operation. In sinking the station well, a horse was used part of the time and was found entirely satisfactory. In order to fill the sand-bucket by horse power, the rope instead of being tied to the single-tree was merely run through the ring of the single-tree, while a man grasped the double rope a few feet from the horse as illustrated in Fig. 8. After the sand-bucket was raised a sufficient distance, the man let go of the rope, thus allowing it to run back with the weight of the falling sand-bucket. As soon as the bucket struck the bottom of the well, the rope was again grasped quickly as before, the operation being thus repeated again and again until the sand-bucket was filled, the horse moving forward all the time. The horse was then brought back to the well and the sand-bucket drawn out and emptied. By using a horse, one man and the superintendent who may empty the sand-bucket, can sink a well, if strict economy is required, but it usually saves time to provide two men in order to handle the weights and turn the pipe with ease. Without a horse there should be three good men in addition to the superintendent.

Fig. 7. Showing the teeth cut in lower of well pipe to aid in sinking.

Gravel was struck at a depth of thirty-two feet, and the teeth in the bottom of the pipe were found to be of great assistance in pushing aside the gravel during the turning of the pipe. The drill was used occasionally in order to loosen the bed of gravel, and to break any stones that were too large to enter the sand-bucket. The pipe was sunk a few feet below the gravel, so that the strainer could be located at the proper place without interference from the sand rising through the bottom of the pipe. The

strainer was fastened to a 1¼-inch pipe with a fine copper wire strong enough to support its weight, and yet sufficiently thin to be easily broken when the small pipe was withdrawn. Just before lowering the strainer into the well, the sand which had accumulated in the bottom was removed with the sand-bucket, the strainer then being lowered and the small pipe securely anchored at the top, thus leaving the strainer suspended. (Fig. 9.) The small pipe to which the strainer was fastened was closely watched during this operation to guard against any possible displacement of the strainer by the upward thrust of the sand. The well pipe was then jacked up until all of the perforated part of the strainer was left exposed, as shown in Fig. 10.

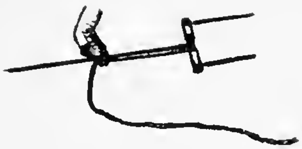


Fig. 8. Single-tree with rope, illustrating the adaptation of horse power in sinking.

SOILS PENETRATED.

Fig. No. 11 illustrates the soils penetrated. It will be seen that the first five feet of soil consists of heavy clay (adobe). Beneath this was sand of varying fineness to a depth of thirty-two feet, when a gravel stratum twelve feet thick was encountered mixed with from 20 per cent to 50 per cent of sand. Below this gravel stratum came another of sand three feet thick, followed by another gravel stratum one foot thick.

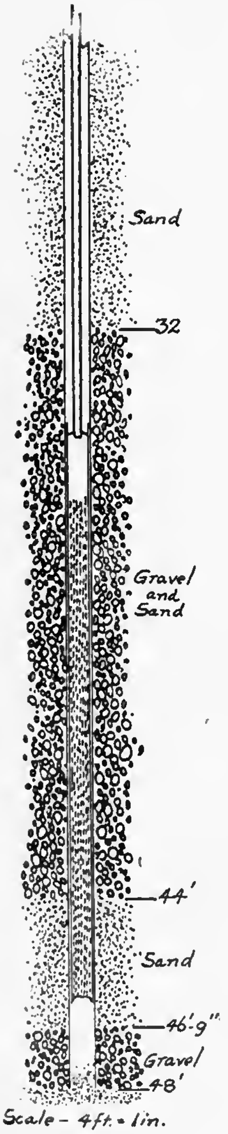


Fig. 9. Slotted strainers suspended in well by one-fourth inch pipe prior to placing.

Fig. 10. Strainer in place, well pipe jacked up. (Note the position of sand and gravel before any pumping has been done and compare with Fig. 11.)

STRAINER.

The strainer used, a small section of which is shown in Fig. No. 12, was 14 feet long, closed at the bottom and made of No. 16 gauge galvanized iron, 12 feet of which was perforated with holes 1½ inches long and ¼ inch wide, the intervening spaces being of like dimensions. This type of strainer furnishes the largest safe amount of open space through which water can enter the well. The openings are sufficiently large to permit all the sand to enter the well and be pumped out, and at the same time small enough to restrain the gravel, thus forming a very porous water-bearing stratum. One or two feet of blank at the top of the strainer is important, so as to avoid possible danger of disconnecting the pipe and strainer.

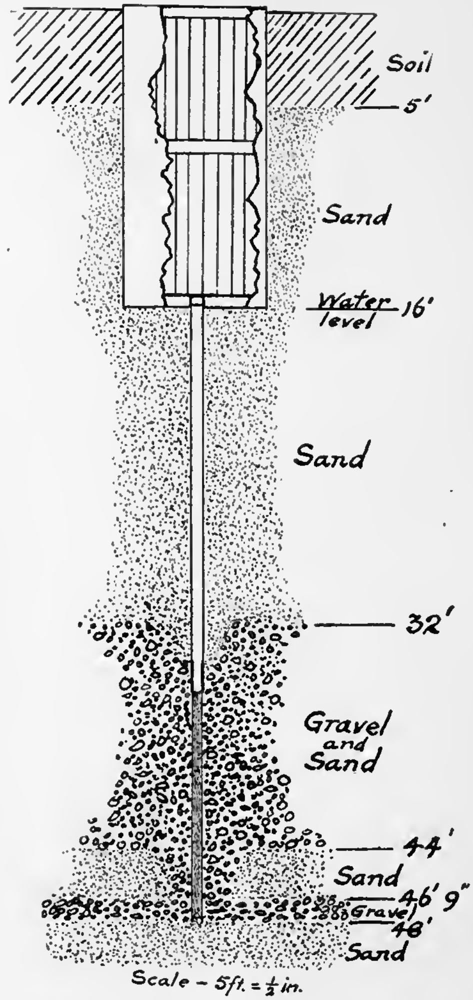


Fig. 11. Showing the Station six inch well, with curb 8x9 feet by 16 feet deep. The position of sand and gravel strata are shown after the well has been pumped for some time. (Compare with strata shown before pumping in Fig. 10.)

The El Paso Novelty Works, El Paso, Texas, makes a strainer almost identical with the one described above. The El Paso Foundry and Machine Company, El Paso, Texas, also makes a strainer of this type, but with some difference in detail.

Fig. 12½ illustrates a home-made strainer, made and used by Mr. J. S. Porcher, El Paso, Texas.

PLACING THE STRAINER.

The success of the well may depend upon the proper location of the strainer in the gravel stratum. If the stratum consists of pure gravel the top of the strainer may be placed about one foot below the top of the gravel stratum, but in cases where 20 per cent to 50 per cent of sand is intermixed with the gravel the top of the strainer should be placed not less than four feet below the top of the gravel stratum. This is

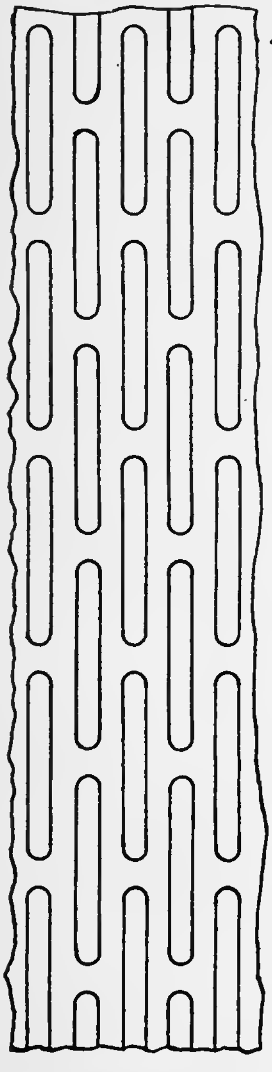


Fig. 12. A section of the wall of the slotted strainer used in Station well; slightly reduced in size.

Fig. 12½. A homemade six-inch slotted strainer, made and used by J. S. Porcher, El Paso, Tex.

necessary for the reason that since the slots of the strainer are ¼ inch wide all the sand surrounding the strainer will enter the well and be pumped out with the water, and the gravel, which is held back by the strainer, will settle to tkae the place of the sand removed. If the top of the strainer were placed at the top, or near the top, of the gravel stratum it will be readily seen that when the gravel settles after the sand has been removed, the top of the gravel stratum will be considerably below the top of the strainer and, therefore, a portion of the strainer would be surrounded by pure sand. This would mean that the sand around this portion of the strainer would constantly be coming into the well, and eventually enough sand would be removed so that caving would finally extend to the surface.

IOWA'S GREAT DRAINAGE CONVENTION.

Large Attendance by Prominent Landowners—Professor Stevenson's Report of His Investigations.

At the opening of the Iowa drainage convention at Ames President Charles F. Curtiss stated that the object of this convention was to unite upon some plan of action that shall result in effective good for the districts; that the seasons of 1902 and 1903 show must have relief from the flooded conditions to render the land productive. The Department of Soils of the Iowa State College, Professor Curtiss stated, has been studying the drainage conditions of the State for several months.

Prof. W. H. Stevenson, in charge of the Soils Department of the College work, made a very interesting and significant report of his thorough investigation of the present drainage conditions in Iowa. Following are some of his principal points: A letter of inquiry was sent out all over Iowa. The following are some of the questions it contained: How many acres in your farm? How many acres partially unproductive the past season on account of surplus water? How many acres wholly unproductive? How many rods of tile have you on your farm? What sizes? Have you an adequate outlet? Would a drainage ditch be of value to you and your neighborhood? What per cent of the land in your township do you think is now unproductive because of a lack of drainage?

About 1,800 replies were received from a half dozen to forty from each county. Professor Stevenson gave and explained a summary of the reports from a few counties and districts, and the average for the State as follows:

The average size of farm reported for the whole State is 249.1 acres.

The per cent of ground partially lost for lack of drainage on the farms reported, average for the State, 16.4.

Per cent of land wholly lost for lack of drainage, average for the State 6.7.

Per cent of farms with no outlet, average for the State, 40.1.

Per cent of farms requiring a district drainage ditch, average for the State, 25.9.

Per cent of land in the township non-productive for lack of drainage, average for the State, 12.4.

With the above data as a basis, Professor Stevenson has done some figuring in profit and loss, and here is what he makes out: Number of acres non-productive for lack of drainage in the whole State, 4,321,792. Annual loss for lack of drainage in the whole State, $21,608,960.

The above annual loss equals 5 per cent interest in the whole State, $432,479,200. Cost of proper drainage in the whole State, $108,044,800. The present annual loss from lack of drainage would pay 5 per cent interest on the above cost of drainage, and also pay 5 per cent interest on the following additional amounts representing increase of wealth that would result from proper drainage, in the whole State, $324,134,400.

Annual loss to the State for lack of drainage, $21,608,960. Value of wheat in State, $12,860,000. Value of the oat crop in State, $26,114,000. The loss from lack of drainage is nearly double the wheat crop of this State and is more than four-fifths of the oat crop.

The annual returns from an acre are about $10.00, but in order to be very safe and conservative in figuring

the above loss, Professor Stevenson has counted only half that, or \$5.00 an acre on the non-productive acres.

Now the value of land has so greatly increased in Iowa and the loss from the lack of drainage is so great, Professor Stevenson is satisfied that the time has come to devote serious attention to this matter of drainage, and by concerted and intelligent movement accomplish large things in drainage throughout the State, and thereby increase Iowa's productiveness and profits.

PRESENT CONDITION OF FARM LANDS.

County or District.	Size of farm......	Per cent partially lost	Per cent wholly lost.	Per cent of farms with no outlet....	Per cent of farms requiring ditch	Per cent of non-productive land in twp.
Humboldt	249	26	17.9	87.5	87.5	29.5
Boone	167.4	14.1	3.7	60	38.1	19.4
Jefferson	182.2	73.3	3.6	16.7	16.7	27.5
Monona	379.6	69.4	43.4	77.7	88.8	36.3
District No. 2...	272.8	25.7	10.1	69.5	55.6	18.9
District No. 5...	197.2	14.5	6.7	53.2	23.3	12.1
State	249.1	16.4	6.7	40.1	25.9	12.4

STATEMENT OF PROFIT AND LOSS.

Counties.	Number of acres non-productive...	Annual loss....	Profitable limit of expenditure.........	Cost of drainage........	Increased wealth......
Humboldt.	82,383	\$ 411,915	\$ 8.238,300	\$ 2,059,575	\$ 6,178,725
Boone.....	70,00	350.000	7,000,000	1,750,000	5.250,000
Jeffersoo ..	73,752	368,760	7,375,200	1,843.800	5,531.400
Monooa...	140 401	702,005	14,040,100	3,510,025	10,530,075
State......	4,321,792	21,608,960	432 479,200	108,044,800	324,134,400
Annual loss to the State					\$21,608.960
Value of wheat in State					12,850,000
Value of oat crop in State					26,114,000

Prof. A. Marston, of the Department of Civil Engineering, Iowa State College, gave a very practical address on the "Essentials in Drainage Engineering." He said in part:

"We can not be too well informed regarding the scientific principles and practical methods of drainage engineering. In Iowa we have too often entirely forgotten the existence of the drainage engineer, or have decided to "save" his fee by dispensing with his services.

"One farmer who has spent a large sum for drainage estimates that he himself lost \$500.00 by not employing a competent engineer. The wet seasons of 1902 and 1903 have shown in a very forcible way the disastrous consequences to Iowa farmers of ill-advised plans, and improper construction in drainage work. Drainage engineering, like law and the practice of medicine, requires so high a degree of technical skill that it is as unreasonable for the untrained individual to think he can do his own drainage engineering as it would be for him to insist on doing his own doctoring. The mistakes of both are covered up in the ground.

"The most important part of the drainage engineer's work consists, first, in planning a system of drainage to secure the best results with the least expenditure; second, directing the successful execution of the construction plans. These require the best training, intelligence, common sense, and the strongest will power and integrity; no man can properly be entitled an engineer in any special line until, in addition to his general knowledge, however extensive, he has had impressed upon his mind by actual experience the thousand applications and modifications which are absolutely essential in each line of engineering work."

The essential need of drainage maps, what they should show, the character and depth of successful tile drainage, the work and worth of a competent drainage engineer and essential points to be taken up in Iowa drainage construction work, were interestingly brought out before the convention by Professor Marston.

The drainage laws of other States were interestingly reviewed, and most helpful suggestions for legislative action for Iowa drainage were given by that most competent drainage expert, **Mr. C. G. Elliott**, of the United States Department of Agriculture.

The drainage laws of other States were interest-the legal standpoint by Messrs. John Hammil, of Britt, and J. F. Ford, of Ft. Dodge, Iowa, who pointed out many defects, suggested adequate remedies, recommending legislative action by the State Assembly now in session.

DRAINAGE PROBLEM IN INDIANA.

Crown Point, Ind., Jan. 13.—*To the Editor of* Irrigation Age: Having just encountered something out of the ordinary in drainage proceedings, it may be of interest to your readers, so will briefly report it to you.

In Lake County, Ind., there is located a small lake containing about 1,000 acres, bordering which the riparian ownership is so valuable as to have been successful in obtaining a perpetual injunction against lowering the water of the lake below its present elevation. At one end of this lake lays a marsh of 500 to 600 acres on about the same elevation as the water of the lake. The owners of this marsh began proceedings in the court for drainage of these lands.

Such lands are surrounded by hills rising twenty to thirty feet above the marsh. At one point these hills narrow down to about three-eighths of a mile across, along the opposite side of which a valley extends that is about eight feet lower than the marsh. The water from the marsh naturally flowed to the lake, thence by a tortuous route from the opposite into this valley, hence any means of draining the marsh into this valley would not be diverting the water from its natural course.

We therefore planned a system of lateral open and tile ditches through the marsh and concentrated them at an available point of said ridge of hills, through which we propose to tunnel a distance of 1,900 feet and lay a three-foot sewer pipe at a depth of about thirty-five feet below the crest of the ridge, and empty the same into the before-mentioned valley.

The marsh will also be protected from inflowing water from the lake by a clay dike. The cost of the undertaking is estimated at only eleven thousand dollars and will convert the now valueless muck and peat lands into the richest garden.

F. L. Knight.

The stockholders of the Otto Gas Engine Works have decided to increase the capital of the corporation from \$600,000 to \$2,500,000 and build a large new plant just at soon as the management can find a suitable site for the purpose.

Large gas engines, producer gas plants, launches and marine engines, gasoline hoists, compressors and other adaptations of the gas engine will be built promptly at the new plant.

IRRIGATION IN BRITISH COLUMBIA.

CANADIAN PACIFIC RAILWAY WILL RECLAIM THREE MILLIONS OF ACRES IN THE BOW RIVER COUNTRY.

CALGARY, ALBERTA, Jan. 14.—*Editor Irrigation Age:* In your issue of December I have noted with much interest your article on the large irrigation project which is being undertaken in Idaho, and I have thought that with reference to the statement therein contained as to the size of the proposed project you might be interested in having some details of the irrigation project which is now being dealt with by the Canadian Pacific Railway Company in this district, particularly as you will note that it is a much larger undertaking, in so far as area of irrigated land is concerned, than the project referred to in your issue of the above date.

The project is, I think, one, if not the largest irrigation undertaking on this continent. It embraces an area lying east of this point 150 miles east and west and sixty miles north and south, through the center of which the main line of the Canadian Pacific Railway runs. The soil in this large district is first-class, and during most seasons it affords a good summer range for cattle. The rainfall, however, during the majority of years (about eleven inches) is insufficient to secure crops, and although the climate is good, being milder than the wheat belts further east in Assiniboia and Manitoba, the district is at present practically unsettled and undeveloped, while other portions of our Territories are settling up very fast.

Along this portion of the railway line the company was originally allotted the alternate or odd numbered sections in each township as part of its land grant subsidy, but refused to take them on the ground that they were unfit for settlement without irrigation. Ultimately, in satisfaction of the balance due it on its land subsidy, the company agreed to take these sections if they were granted also the even sections and sections set apart for school endowment, so that it might have a solid block of three million acres, and that is the area that the company is now going to attempt to reclaim by the construction of extensive irrigation canals.

The water for irrigation is to be obtained from the Bow River, which bounds the block on the west and partly on the south side, and which is a stream heading in the Rocky Mountains to the west, and carrying about 3,000 second feet at extreme low water, with a high water or flood discharge of 30,000 to 40,000 second feet.

The greater part of three years has been devoted to reconnoisance and preliminary surveys of the proposed canal scheme and the land to be served therefrom, and the result of these surveys as now assembled indicates that about one-half or 1,500,000 acres of the block can be irrigated, at an ultimate cost of between four and five million dollars.

The actual construction of the first section of the undertaking is now about to be proceeded with, involving the construction of a main canal twenty miles in length, with a bed width of sixty feet, and carrying water to a depth of ten feet, this canal being so located that its bed width and discharge capacity can be doubled.

Some eighty-five miles of secondary or distributing canals have also been located, and the completion of this section of the scheme, at an estimated cost of about $1,300,000, will irrigate an area of 300,000 acres, and render available a continuous area of about 400,000 acres for grazing and dairying.

This portion of the scheme is to be first completed and proved a success before any further extension is undertaken, but if success is obtained, then the necessary extensions will be undertaken to finally irrigate the full amount of 1,500,000 acres, and develop the remaining 1,500,000 acres for grazing and dairying. This extension will involve the enlargement of the main canal to double its present capacity, the development of several large natural basins as storage reservoirs, and the construction of a second canal for diversion of water from Bow River at a point about eighty miles down the stream from the intake of the main canal now being constructed.

Irrigation is not in any sense an experiment in Alberta, there already being 160 canals and ditches, comprising a total length of 400 miles, which are delivering water for irrigation. The country, however, presents certain features which render the irrigation problem a somewhat different one to that of the irrigation States to the south.

Southern Alberta is only a semi-arid country in the sense that its annual precipitation shows marked fluctuations, not only from year to year, but for cycles of years, and during the wet cycles, such as have been experienced for the past three years, irrigation is unnecessary. This condition, of course, has a marked effect upon the return from expenditures on irrigation undertakings, and limits the possible capital charge per acre for water for irrigation in a very marked way. However, irrigation has proved the most profitable kind of crop insurance even under existing conditions, and the hope is that the large project we are now undertaking will result in rendering a large area, now almost entirely devoted to wandering bands of cattle, highly productive, and the home of a large and prosperous agricultural population.

You will probably have noted from late issues of the *Engineering News* and *Engineering Record* that tenders for the construction of the main canal are being asked for, and a full set of our plans, profiles, specifications, etc., are in the hands of our general passenger agent, Mr. A. C. Shaw, 228 South Clark street, Chicago.

Yours truly, J. S. DENNIS,
Superintendent of Irrigation.

CAN YOU ANSWER?

GENOA, NEB. Dec. 27, 1903.

THE IRRIGATION AGE AND DRAINAGE JOURNAL:

Dear Sirs—I should like one or two copies of the IRRIGATION AGE for the purpose of getting the names of advertisers of drain tile. If you have any price lists of tile from your advertisers would be glad to have you enclose them.

Yours sincerely,
L. D. CREEL,
Teacher of Agriculture, Genoa Indian School, Genoa, Neb.

ELDORA, IOWA, Dec. 23, 1903.

THE IRRIGATION AGE AND DRAINAGE JOURNAL:

Dear Sirs—Can you give me any light on pile driving machinery? The *Iowa Homestead* referred me to your company. What I would want is a mall about 1,200 pounds, with clutches and pulleys all complete except the derrick. Now, if you should make such machinery, will you please let me hear from you and oblige. Truly yours,
F. E. SPRAIN.

THE PRIMER OF IRRIGATION.

Chapter IX.

PREPARATION OF SOIL FOR PLANTING.

One great object of cultivating or tilling the soil is to break up and loosen the earth, in order that the air may have free access to the dead vegetable matter in it, as well as to the living roots which spread and descend to considerable depth beneath its surface.

If it be desirable to have a luxuriant vegetation upon a given field of land, that is, a good crop, one must either select such kinds of seed as will grow in it, or which are fitted to the kind of soil in which they are planted, or change the nature of the soil so as to adapt it to the crop it is desirable to raise.

It is not denied that plants will grow in any soil that contains the general elements essential to their existence, but when the quantity and quality of the crop are considered as of importance, it is useless to "guess," for only partial satisfaction will result, and often entire failure, which is usually attributed to the elements or to the wrath of Providence.

Farming for profit means that the farmer knows every foot of his land and the nature of the soil; what it will grow and what it needs. A lack of this knowledge is farming for luck, and is equivalent to gambling with the eyes shut. There is less labor and twice the profit in harvesting forty bushels of wheat on an acre of properly cultivated soil than forty bushels on two acres roughly tilled. The case is the same with any sort of crop, and this is so plain that it seems absurd to mention it, yet it is forgotten in numerous cases of farmers, who go more on quantity of acreage than perfection of cultivation and increase of crop. It is not extensive farming that pays so well as concentrated farming. A man with one hundred acres well in hand is better off than another with five hundred acres of struggling crops. Wholesaling in any business is more expensive and the returns less than in retailing, and every farmer knows, perhaps by bitter experience, that everything about a farm is attended with expense, if not always in cash money, then in a draft upon his future strength and vitality. Irrigation, however, promises to be a cure for rambling farming, by compelling concentration. Why spread water over one hundred acres to raise a sparse crop when the same or much less water will secure a fine, luxuriant crop on twenty-five acres? When a single grain of wheat may be made to stool out into sixty plants, is not that better than when it stools out into only twenty? The former shows health, vigor, and productiveness, the latter mediocrity. The one means a syndicate, the other a home.

The new beginner, the small farmer, reads accounts of the great farming schemes, the thousands and thousands of acres which run bank accounts into five and six figures. He dreams of gang plows, steam plows, combined harvesters and reapers, his fat cattle upon a thousand hills, and he swells himself up like the toad in the fable to equal the ox, and bursts in his effort. Let the reader desirous of gaining a competency through farming, acquire a home before he is worn out in the struggle, before his patient wife sinks beneath the sod in the effort, and his children grow up into cowboys, rustlers and desperadoes, imitate nobody, read none of the glowing accounts of successful great farmers without at the same time understanding that all such began, as a rule, on enormous capital, took a magnificent ranch through the early demise of a worn-out ancestor, through a mortgage foreclosure of some "imitator," or raises himself to grandeur upon the cheap labor of his fellowmen. Let him take the soil and treat it as the foundation for a home, for plenty, and the other things will come to him.

It was said in a former chapter that plants are like animals, in that to grow to perfection they must be properly managed and fed. A half-starved hog produces poor bacon, a chaff-fed horse has little energy, the wool of a starveling sheep is coarse and wiry, and even a human being, limited in his diet or restricted in nourishment, possesses a flabby, shriveled brain and a weak physical energy. Men say of animals: prune, cultivate, select, feed; of men: prune, cultivate, feed, and wherefore not say the same of plants and the soil: prune, cultivate, feed? Herein is the whole science of preparing the soil for cultivation, the heredity of plants, their atavism, their environments, the survival of the fittest, and whatever else may be said of animals and humanity. But to return to the great vegetable kingdom.

All of our practical writers agree, and the every-day farmer knows by his personal experience, that as the systems of roots, branches and leaves are very different in different vegetables, so they flourish most in different soils. The plants which have bulbous roots require a looser and a lighter soil than such as have fibrous roots, and the plants possessing only short fibrous radicles demand a firmer soil than such as have tap roots or extreme lateral roots. But it may be considered as a truism that shallow cultivation of the soil always produces minimum crops, whereas maximum harvests are gleaned by deep plowing whatever may be the plant.

It is always a question of the ability of the roots to reach out after food and their exposure to air. To comprehend this fully it should be considered that there is about as much of the plant under ground as above it, and the experienced farmer can always tell by the growth of his crop above ground whether the roots are doing well under ground, if the growth is not in accordance with the natural progress of the plant, there is some obstacle below the surface which can be removed by cultivation, the loosening up of the soil to a sufficient depth. How quickly growing corn revives and takes a new lease upon life after deep cultivation between the rows! Not shallow cultivating, or scratching over the surface, but 'deep plowing.' Level with a shallow cultivator afterward, of course, then hoe and see the stalks shoot up. It is some trouble, certainly, but do you not depend upon a good crop to make money, and to obtain a home? It is also a trouble to raise a child, but when it grows up straight, is not the labor more amply repaid than when it grows up crooked and stunted?

The character of the cultivation, however, depends upon the condition of the subsoil. Where that is hard or packed, it must be broken through, and up, to permit root penetration. Frequently, not to say generally, there is moisture beneath the hard, packed sub-soil, and by breaking through the moisture finds its way up and "slakes" the hard pan or other resistant subsoil. There is also a difference in cultivation between the soils of the arid and the humid regions, differences which are atmospheric and also in the quantity of the organic elements which will be made apparent as we go along.

It seems unnecessary to repeat so simple a thing when it should be as plain as day, that plants possess

an instinct that does not fall far short of the marvelous. For instance, in the arid regions the plant sends its roots down deep and out in every direction after the moisture which it apparently knows it can not get at the surface or near it, whereas, in the humid regions, the roots spread out more, because they apparently know that the moisture is near the surface and they do not have to toil so hard to make their way down deep. Anyone practicing surface irrigation will know that the roots of plants which have a habit of penetrating deep into the soil, grow along the surface, because the moisture is there. Plants always adopt the easiest method of obtaining food.

Now why do plants travel after moisture and not after dry soil? It is not water plants need, nor is it moisture, but it is food. They know that there is food material in the dry soils, but it is not in a fit condition to be absorbed, whereas, moisture prepares the food for them, hence they refrain from pursuing the raw material and expend their energies in seeking the manufactured product. Let a garden patch which has been kept moist, and in which the roots congregate, be allowed to dry, and another patch that has been dry and away from which the roots turn, be moistened, and the plants will grow away from their former hunting ground and in the direction of the new one. This is common observation. A beet root has been known to travel sixteen feet in the direction of a well where it knew it could get a drink, although plants, as a rule, are not drinkers but feeders of the most pronounced Epicurean type.

In the arid and semi-arid regions it is better to provide for a deep burrowing of the roots, because when they frequent the surface, they are liable to suffer from drought, or surface dryness. In this the reader will find an argument in favor of sub-irrigation.

Upon this instinct of roots to seek their proper food in moist soil, depends the measurement of soil tillage, whether deep or shallow, and by "shallow" is not meant a mere surface scratching, but a good wholesome upheaval of the soil from a depth of eight to twelve inches, thence on up to eighteen if the subsoil be in question. Where the subsoil is not hard packed, then as deep as the subsoil; if packed it should be broken up. But where the subsoil is open and porous there is less need of deep plowing; on the contrary, it may be necesary to pack the bottom of the furrow, which is accomplished by a plow attachment known as a "packer," so arranged as to follow the plow and press down the earth at the bottom of the furrow; a useful contrivance where irrigation is practiced, inasmuch as it tends to prevent the leaching of the irrigation water down into the porous subsoil, where the water is run into the furrows.

It can not be too strongly impressed upon the reader that the soil must be so cultivated that it will retain moisture without permitting it to leach beyond the reach of the roots, and at the same time so broken up and pulverized that the roots may easily penetrate. Let this be the axiom constantly in mind: Give the plant roots room to spread. Upon this depends the perfection of the plant. "Stunts" are always caused by too little root room, the plant languishing because they are unable to reach moisture by reason of obstacles in the soil. If there is any moisture in the soil the plant will get it if it be given an opportunity.

Let us assume that we have a parcel of land in which it is purposed to grow plants without the application of manure. It does not matter whether it be virgin soil or one that has already grown a crop of any kind; the first thing to be done to this land is to improve the soil, that is, prepare it for vegetation. This may be done in seven ways:

First—By cultivation, or, more properly speaking, pulverization of the soil, by plowing and other mechanical means of reducing its consistency.

Second—By mechanical consolidation.

Third—By exposure to the atmosphere; that is, "fallowing."

Fourth—By alteration of its constituent parts.

Fifth—By changing its condition in respect to water.

Sixth—By changing its position in respect to atmospheric influences.

Seventh—By a change in the kinds of plants cultivated, or "rotation of crops."

PLOWING AND PULVERIZING.

All these different methods of preparing the soil means practically the same thing—the breaking up of the soil, which must be done constantly if a good crop in quantity and quality be desirable.

By reason of their chemical elements the tendency of all soils is to concrete; that is, to run together into a sort of more or less hard cement, a tendency enhanced by the growing of crops and the application of water, or either. Thus, sand without consistency and quicklime without coherence, when mixed together with water, produce a hard cement or plaster, which may be crushed and pulverized before it can become again manageable. In soil the chemical agencies of nature are constantly at work to produce the same result; hence cultivation to break up a tendency which is adverse to the growth of plants and free root penetration.

The very first object of cultivation is to give scope to the roots of plants to spread in every direction, for without abundance of roots no plant can become vigorous, whatever may be the richness of the soil in which it is placed. The quantity of food taken from the soil does not depend alone upon the quantity in the soil, but on the number of absorbing root fibres. The more the soil is pulverized the more the fibres are increased, the more food is obtained, and the more vigorous the plant becomes. Any house plant growing in an earthenware pot will demonstrate this. The roots grow down and then, finding an obstruction, begin growing round and round in search of food, until the entire pot is filled with root fibres, even forcing out the soil to find room, and when they have grown to the limit of their confined space, the plant stops growing and becomes sickly.

This cultivation or stirring up of the soil for root expansion is not only essentially precious to planting, or sowing, but highly beneficial afterward, during the progress of vegetation; and when practiced in the spaces between the plants it also operates as a method of root-pruning, by which the extended fibres are cut off, or shortened, thereby causing them to throw out numerous other fibres whereby the mouths or pores of the plants are greatly increased, and their food capacity enhanced. It is very much like fattening animals for market by encouraging their consumption of fattening food.

Cultivation renders capillary attraction more uniform, this peculiarity of the soil being greater when the particles of earth are finely divided. Thus, gravels and sands scarcely retain water at all, while clays, not opened by pulverization or other means of breaking them up, either do not readily absorb water, or when exposed

to long action, they retain too much of it. In the arid regions deep cultivation is essential to admit moisture from the atmosphere, as for example, the dews of night. In irrigated sections deep and thorough cultivation checks evaporation and reduces the accumulation of alkali salts to a minimum, besides saving water.

Heat is tempered by deep cultivation, which is a great desideratum in the arid and semi-arid regions, the layer of pulverized soil serving the purpose of shade or mulch, and the evaporation retarded, the moisture acquires a uniform temperature. This seems to be a small matter in plant growth, but practical experience has demonstrated that it is an important part of the general combination of practices which result in successful agriculture.

Whenever the soil is opened, turned over and otherwise prepared for planting, a portion of the atmospheric air is buried in the soil and this air so confined, is decomposed by the moisture retained in the earthy matters. Ammonia is formed by the union of the hydrogen of the water with the nitrogen of the atmosphere, and nitre by the union of oxygen and nitrogen. So also, the oxygen of the air may unite with the carbon contained in the soil and from carbonic acid gas. Heat is given out during all these chemical processes. As a rule farmers do not pay much attention to these simple facts, but the plants he is growing do, and they are more or less benefited as they are permitted to take advantage of these laws of nature, or prevented.

The depth of cultivation must depend upon the nature of the soil and the variety of plant grown in it. The subsoil, also, is not to be disregarded. Rich clayey soils can hardly be cultivated too deep, and even in sands, unless the subsoil contains alkali in dangerous quantities, or other plant poisons, deep cultivation should be practiced. When the roots are deep they are less liable to be injured by excessive water or drought; the radicles are shot forth into every part of the soil, the space from which nourishment is to be drawn being extended over a much greater extent than when the seed is superficially inserted in the soil.

In this respect cultivation should be attended with a thorough mixture of the soil by turning it over and over. Plowing, of course, accomplishes this result in a great measure, but the difference of gravity between the organic and the inorganic matters in the earth, has a tendency to separate them, for which reason light or shallow stirring of the soil is of little or no use practically, because it leaves the surface of the soil too light and spongy and the lower part too compact and earthy. Even where the plant roots are near the surface cultivation with a plow and a complete turning over of the soil is much better than the mere scratching of the surface, for there, as has been said, it is equivalent to root pruning.

In a former chapter reference is made to the fact that plant roots consume all the food in their neighborhood, and this furnishes another obvious reason for deep cultivation, otherwise the roots of a new crop reaching out for nourishment find an empty cupboard.

Some soils, however, require the opposite of pulverization and demand mechanical consolidation. This will be understood in the case of spongy peats and light, dusty sands. A proper degree of adhesiveness is best given loose soils by the addition of earthy matters in which they are deficient, perhaps the bringing up of a heavier and more consistent subsoil will accomplish the purpose. Rolling and treading, however, are simple methods, but in that case the soil must be dry, and the operation must not be carried too far, or so far as to concrete the earth, which is its constant tendency, as has been observed.

A peat bog drained and rolled will sooner become covered with grass than one equally well drained but left to itself. Drifting sands, however, may well be rolled when wet, and by repeating the process after rains or floodings, they will in time acquire a surface of grass or herbage. Light soils should always be rolled, and the seeds should be "tread in" when planted, a pat with the hoe not being sufficient, as in the case of heavier soils, unless the seeds be very small.

Exposure to the atmosphere, speaking with reference to soils, means "lying fallow," the only benefit of which, and sometimes it is not a small one, is to expose insects and their eggs, weeds and their seeds, to destruction. In climates where there are severe winters and hard frosts, a hard, lumpy soil becomes pulverized by the action of the frost, and soils that have become soured, sodden and baked by the tread of cattle or other cause in wet weather, are more rapidly sweetened and restored to friability by exposure to the hot sun of summer, than by the frosts of winter. Some maintain that the only benefit of fallow, that is, turning up the soil roughly to the atmosphere, is to free the soil from the roots of weeds. There is nothing, indeed, in the idea that the land "needs a rest," for if properly cultivated, soil will keep on producing as long as there are any elements capable of feeding plants. The idea originated in ancient times when lack of help to till the entire farm, or a deficient supply of manure, compelled the suspension of cultivation on certain parcels or fields. It is certain that what is called an "exhausted soil" obtains no renewing material from the atmosphere.

To alter a soil is to add or subtract the ingredients which are lacking, or which exist in excess. The so-called "alkali soils" are an illustration of excessive ingredients, and any sterile, sandy or gravelly soil may be regarded as one representing a deficiency of food producing elements. In case of sterility, the only remedy is to add the ingredients lacking, or convert sterile material into fertile ones by chemical means. Thus: where in sterile soil, on washing it, there is found the salts of iron or acid matters, the application of quicklime will ameliorate it, and in a soil of apparently good texture, but sterile on account of the sulphate of iron, a top dressing of lime will afford a remedy by converting the sulphate into a manure.

If there be an excess of calcareous matter in the soil it may be remedied by the application of sand or clay. Too much sand is improved by clay, marl, or vegetable matter, and light sands are benefited by a dressing of peats, and peats improved by adding sand. The labor of thus improving the texture or constitution of the soil is more than repaid by the requirement of less manure, in fact, accretions in the way of new soil are a natural manuring and insure the fertility of the soil, where manure might be doubtful on account of its adding an excess of organic matter, which is equally as deleterious to plant growth as too much inorganic matter. An equal number of tons of sand, clay, marl, or other natural soil, as of manure, will often tend to greater productiveness than from the addition of manure. When there is an excess or superabundance of soil material, the problem of its removal is much more difficult and serious, the reclamation of alkali lands abundantly demonstrating this. Ordinary sand and gravel may be plowed

under, scraped from the surface, or partly washed off by flooding, particularly where the lay of the land is sloping. In the case of alkali, as has already been said, drainage, or exhaustion of the soil by the cultivation of gross feeding plants seems to be the reasonable remedy; at all events it proves effectual.

Burning over the soil was an ancient method, one used by the Romans to alter the constituents of the soil, the object being to render the soil less compact, less tenacious, and less retentive of moisture by destroying the elements that tend toward holding it in a concrete consistency.

It is practiced in the United States for the same purpose, but in the vast areas of the boundless West, where a man is not limited to a small acreage of the soil, it is not regarded as worth the labor, although it might in many instances be beneficial. The soils improved by burning are all such as contain too much dead vegetable fiber, by the burning of which they lose from one-third to one-half of their weight. So stiff clays, adobes, hardpans, and marls are improved by burning. But in the case of coarse sands, or where the elements of the soil are properly balanced, burning is detrimental, and the same is the case in silicious sandy soils after they have once been brought into cultivation.

As to changing the condition of lands in respect to water, the subject belongs to irrigation, but it may be said here in passing, the land should be cultivated, having in mind the flowing of water, whether from irrigation or rain, so as to avoid the accumulation of stagnant water, which is injurious to all classes of useful plants. When the surface soil is properly constituted and rests on a subsoil moderately porous, both will hold water by capillary attraction, and what is not so retained will sink into the substrata by its gravity; but when the subsoil is retentive, it will resist the percolation of water to the strata below and thus accumulate in the surface soil, and, making the latter "soggy," will cause disease to the plants. Hence the origin of surface draining, that is, laying land in ridges or beds, or intersecting it with small, open gutters, a very good practice where irrigating water is used, for into them the water may be turned and then plowed over, left to come up to the surface where the plant roots can reach it. The alteration of land by water will be treated in detail in its proper place under the head of "Irrigation."

We have already referred to the effect of the sun's rays on land, and add here that in cultivating, there is one advantage in ridging lands and making the ridges run north and south, for on such surfaces the rays of the morning sun will take effect sooner on the east side, and those of the afternoon on the west side, while at mid-day the sun's elevation will compensate for the obliquity of its rays to both sides of the ridge. In gardening there is much advantage in observing this method of cultivation, for the reason that much earlier crops may be produced than on a level ground. Thus, sloping beds for winter crops may be made southeast and northwest, with their slope to the south, at an angle of forty degrees, and as steep on the north side as the mass of earth can be got to stand. On the south slope of such ground of course the crops will be earlier than on level ground. There is little advantage of this sloping, however, unless perfection of garden produce is desirable, although the advantage of sloping is a diminution of evaporation and also a ready natural drainage.

Although rotation of crops will be treated in a special chapter, the subject has a bearing upon cultivation, or treatment of the soil, since the necessity for a rotation of crops seems to grow out of a diminution of certain plant foods desirable to certain plants, and there are many species of plants which require particular substances to bring their seeds or fruits to perfection. It may be that these particular substances are in the soil but beyond the reach of the plant. In that case it is clear that a thorough mixing of the elements of the soil will bring the appropriate food within reach of the plant, or, if that can not be done, then the planting of some other crop, and permitting it to return back into the soil, will afford the required food for the desired plant. In this place, cultivation and thorough mixing is advised. In the proper chapter the whole subject will be treated in detail.

The following are some of the root and soil peculiarities of well known plants:

Wheat—Has feeble roots at surface, but strong tap roots penetrating deep into the soil. Stiff soil.

Oats—Next to wheat, will stand stiff soil, but the plant throws out in the superficial layer of soil a number of fine feeders in lateral directions, and hence the top soil should be light and open.

Barley—It throws out a network of fine, short root fibers of no great depth and requires a light, open loam.

Peas—Require a loose soil, with little cohesion, and spread soft root fibers deep.

Beans—Ramify strong, woody roots in all directions, even in a heavy and compact soil.

Clover—Grass seeds and small seeds generally put forth at first feeble roots of small extent, and require so much the greater care in preparing the soil to insure their healthy growth. The pressure of a layer of earth a half to one inch thick suffices to prevent germination. Such seeds require only just as much earth to cover them as will retain the needful moisture for germination.

Turnips, potatoes, etc.—The nature of these fleshy and tuberous roots clearly point out the part of the soil from which they draw their chief supply of food. Potatoes are found in the topmost layers of soil, whereas the roots of beets, turnips, parsnips, etc., send their ramifications deep into the subsoil, and will succeed best in a loose soil of great depth. Still they grow well in heavy and compact soil properly prepared for their reception.

As to the length of roots it has been found that alfalfa will grow roots thirty feet, flax five feet, clover above six feet, etc., and beets have been known to send out a long, tapering root sixteen feet along the surface, an instance of which has been already noted.

It is on the root that the farmer should bestow his whole care. Over that which grows from it he has no control, except perhaps in the way of pruning or bud "pinching," as in the case of tobacco, melons, fruits, etc.

SERVICE WORK IN CALIFORNIA.

Suptendous Plans of the Government—Organization and General Scope of Procedure.

[*Special Correspondence of Irrigation Age.*]

WASHINGTON, D. C., Jan. 12.—Mr. J. B. Lippincott, supervising engineer for the irrigation work of the United States Geological Survey in California and for the Colorado River has arrived in Washington. He was seen at the office of the Geological Survey and made the following statement:

"The main office of the Reclamation Service in California is located in the Byrne building in Los Angeles. A branch office has been opened at 431 Rialto building, San Francisco, at Yuma, Ariz., and at Bishop in Inyo County. The organization is entirely under the civil service, and the appointment of all the men has been by competitive examination.

IN THE SACRAMENTO VALLEY.

"Mr. H. E. Green, engineer, is in charge of the study of the drainage basin of the Sacramento Valley looking toward its development by irrigation. His headquarters are at the San Francisco office. From present information it is believed that during the spring and early summer sufficient water is normally found in the streams to provide for a very extensive system. The Sacramento River, however, is a navigable stream and it is not deemed wise to make extensive diversions therefrom during the low stage of the river or its tributaries in the mid and late summer months. The water to be supplied for irrigation during this low stage must be supplied from storage reservoirs to be located either on the main stream or on its tributaries. The investigations, therefore, in this drainage basin have been preliminary explorations for reservoir sites and the determination of the available water supply.

"In this work particularly, and other work in general, the State of California is extensively co-operating with the United States Geological Survey in carrying out these investigations, the State paying a material portion of the field expenses, and the Geological Survey paying the salaries of the employes. The Governor of the State is particularly active in his desire to assist in the development of this section by an exhaustive study of its resources, and by bringing the attention of both the nation and the public to the latent opportunities.

"In addition to the work of the Geological Survey the forest cover of the mountainous portion of the basin is being studied by Mr. Gifford Pinchot, forester of the Agricultural Department, and his assistants, with a view to preserving the forests and thus protecting the water supply. The topographic branch of the Geological Survey is also receiving assistance from the State and is concentrating its efforts in the preparation of a contour map of the irrigable lands of the Sacramento Valley. About six topographic parties are now in the field carrying out this work. They are making their maps on the scale of two inches to the mile and with five-foot contour intervals.

WORK IN CACHE CREEK.

"Cache Creek is one of the large tributaries of the Sacramento, entering the valley from the coast range. This tributary was extensively studied by Mr. A. E. Chandler for the Geological Survey. Mr. Chandler is now State Engineer of Nevada.

PUMPS FOR IRRIGATION.

(Special Correspondence.)

In view of the fact that great interest has been created in the subject of pump irrigation during the past few years, THE IRRIGATION AGE has gone into various fields to secure such information as it was considered would be of interest and value to its readers, and has recently taken up the study of pumps to be used for irrigation purposes.

A recent visit to the Agricultural College of New Mexico brought us in touch with the advanced work carried on there by Professors Vernon and Lester, and later on it was our privilege to visit points in California and study that subject with manufacturers and actual users of pumps along this line. While in California we met Mr. A. T. Ames, manufacturer of pumping machinery at Galt, who has established a good reputation throughout the western States on the Ames pumps. While in the town of Galt, which is a small place from which to turn out such quantities of goods as have been manufactured by this firm, it was learned that Mr. Ames has been contemplating for some time a change of location where he could secure better railway facilities, as well as more equitable freight rates, and that gentleman is at the present time visiting cities in the East with a view to securing a suitable location which will be in every way more advantageous to the development of his business.

Mr. Ames is the pioneer in pumping water from deep wells of small diameter for irrigation. He first started in the capacity of general machinist, with a small force, and subsequently reached out into the windmill and pump line. Later he made a visit to southern California to sell windmills and single acting deep well pumps, and learned while there that thousands of dollars were spent for irrigation in tunnels through the mountains, canals, gravity systems of all kinds, artesian wells and suction pump plants, but failed to find any pump in all that section, so he informs us, that would deliver an irrigating head from a deep bored well of small diameter. He further states that he went home and designed a double acting continuous flow deep well pump, the object of the continuous flow being, first, to get the maximum amount of water from a bored well. Second, to overcome the concussion of starting the water column from rest each time the plungers went over the center. Third, to reduce the power and fuel consumption to the minimum.

His first pump manufactured after this idea had a capacity of 8,000 gallons per hour at a 100 foot lift from a 7-inch bored well. Recently Mr. Ames has manufactured a pump with a capacity of 20,000 gallons an hour from a 12-inch bored well at 200 foot lift to the surface, delivering the water 200 feet vertically above the surface through four miles of pipe, if required, with an efficiency of from 75 to 85 per cent, depending on conditions.

We are showing in connection herewith a series of of illustrations of the Ames pumps in operation, which will no doubt prove of interest to all those who have studied pump irrigation, and give them a more comprehensive idea of machinery of this class. The Ames pump delivers a continuous stream with absolutely no water hammer, which is common with some other makes of pumps, and is particularly adapted to be driven by electric power for the reason that the resistance to the motive power is almost uniform. The motor is usually connected by belt or may be connected direct by spur gear and pinion. A farmer or rancher who has a private irrigating system with a bored well, and one of these pumps, is independent of nature's varying moods. If the rains fail, he "gets water from the ground," and so he saves money and mental anguish as well.

These pumps are used largely in connection with railway water supply, in city water works, as well as in mining. As will be seen by the illustrations, several varieties of pumps are made, in fact, five different

MR. A. T. AMES, GALT, CAL.

sizes with a range in capacity from 5 horsepower work to 50 horsepower work, double acting deep well cylinders, made in 22 sizes and lengths, with a capacity up to 500 gallons per minute from a bored well, and in the smaller diameters lifts up to 1,000 feet vertically. Single acting cylinders with removable valves are also made in twenty-five sizes and lengths, good for all lifts up to 1,000 feet. Mr. Ames also makes tubular propeller pumps for bored wells in three sizes, with capacities up to 1,000 gallons per minute from twelve-inch wells at 100 feet or more lift to the surface.

We are showing with a collection of other illustrations a half-tone photograph of the inventor and manufacturer, Mr. A. T. Ames.

AMES TUBULAR PROPELLER PUMPS.

These pumps are designed to deliver large quantities of water at the surface from bored wells of small diameter. The 10-inch pump has a capacity of 1,000 gallons per minute from a twelve-inch well at 100 feet or more lift to the surface.

They require no pit or expensive foundation, are belt driven, efficient, durable and effective, easy to install and operate. They are designed and used in bored wells for the purpose of irrigation, and for wells where water is below suction limit. They may be used in wells that flow at the surface, but when pumped, water recedes one hundred or more feet from the surface. This is important, as it is well known that a suction pump can only lower water in wells twenty feet, while these pumps may be sunk 100 feet into the water and pump at its living source from the bottom of bore.

In conversation with Mr. Ames, it was learned that his business has developed from a purely local trade until his pumps are now sold and are in operation in Washington, Oregon, California, Nevada' Arizona, New Mexico, Texas, Mexico, Hawaii Islands and Australia. Mr. Ames has built up a fine business and has, he states, practically no competition where the largest possible amount of water is required from deep wells of small diameter at the minimum cost for power and maintenance.

AMES TUBULAR PROPELLER PUMP.

Owing to the great interest in artesian water and oil prospects in the Arkansas Valley between Pueblo and Manganola, the United States Geological Survey has had Geologist Fisher in that section for several months to ascertain the geologic structure and artesian conditions. His report is expected in a short time. Geologist Siebenthal, of the Survey, has been at work for some time in San Luis Valley and reports that he has finished about two-thirds of the artesian area. His report will be printed at an early date.

IN THE RIO GRANDE BASIN.

REPORTS OF ENGINEERS REED AND DAVIS ON THE WORK ACCOMPLISHED IN NEW MEXICO.

[*Special Correspondence of Irrigation Age.*]

WASHINGTON, D. C., Jan. 12.—Mr. Arthur P. Davis and Mr. W. M. Reed, engineers of the United States Reclamation Service, have submitted reports covering their work in New Mexico, and same will shortly appear in the Second Reclamation Report.

The work of Mr. Davis and his party has been wholly in the drainage basin of the Rio Grande, the work being largely to supplement that of previous investigations made by the bureau. Mr. Davis had under particular consideration the international dam and reservoir and the Elephant Butte reservoir site.

The first project involves the construction of a masonry dam to reach about sixty feet above low water in the Rio Grande. Such a dam would form a reservoir about fifteen miles in length, four miles in greatest width, covering 26,000 acres, and having a capacity of about 540,000 acre feet. The estimated cost of the entire project is $2,300,000, of which a large proportion is due to the expense of moving sixteen miles of railroad line above the reach of high waters in the reservoir.

The Elephant Butte site was investigated by Mr. C. H. Fitch and Mr. James A. French, and a small party was kept at work during the summer making a topographic map of the canyon. A very careful survey was made of a damsite a short distance below the one selected for the Elephant Butte project, in order to investigate its feasibility. It was found that a dam could be built about one-half mile below Elephant Butte to a height of 170 feet, which would throw the water through a divide to the west, forming a natural spillway. The surveys show that such a dam would form a

reservoir nearly forty miles in length with a storage capacity approximately of 1,494,775 acre feet. Borings at the proposed damsite were begun in October. In August a contour survey was begun in order to map and classify the lands involved in the construction of a diversion canal, and which would be covered by a canal for irrigation. An area of about one hundred square miles has been completed to date.

It is possible that considerable power could be developed by the construction of an irrigating canal in such a manner as to concentrate the surplus fall at points where it may be utilized for this purpose, and the power developed might be utilized in pumping water problem, which is the most difficult and serious obstacle to the utilization of the flood waters of the Rio Grands basin.

The proposed reservoir will not cover any large area of valley land, but depends for its great capacity upon the high dam and a river canyon of very modern declivity, the form of the reservoir being long and relatively narrow. When such a reservoir is partly filled with sediment, as it will be soon after construction, large sluiceways will be opened to provide for the outflow of water at the bottom of the dam, emptying the reservoir. The stream will be made to cut a channel for itself through the impounded sediment.

THIS STREAM OF WATER IS PUMPED BY A NO. 3 AMES PUMP, 112 FEETTO THE SURFACE, FROM A 12-INCH BORED WELL AND DELIVERED IN THIS ORCHARD 30 FEET ABOVE THE PUMP THROUGH HALF A MILE OF PIPE.

from beneath the valley to extend the irrigated area. Until the borings for foundations have been completed the feasibility of the project can not be determined. The reservoir, however, has a much greater capacity than any other on the river, and is ample to store the floods of wet years and to hold them to reinforce the supply in times of extreme drought. It is the only proposed reservoir with a capacity large enough to utilize the entire flow of the drainage basin. It is situated sufficiently low enough in the basin to intercept practically all the waters, and yet is sufficiently high to command enough land to consume all the available water supply. The extremely great capacity here proposed is intended largely for the solution of the sediment

It is estimated by this method the river can be made to sluice out the reservoir and to thus maintain a storage capacity of more than one-half of the original capacity of the reservoir. To obtain this result without injury to the irrigation interests below, it will be necessary to construct an auxiliary reservoir further up stream in the same drainage basin, which will provide the water supply during the sluicing process. The cost of constructing such an auxiliary reservoir and the operation of both the gates of the reservoir would be the only expense attached to the solution of the sediment problem side by this method. The reservoir being relatively deep in proportion to its surface area, there will not be excessive evaporation.

MR. REED'S REPORT.

The report of Mr. W. M. Reed, resident engineer of the Service, is of particular interest by reason of the fact that it is probable the Government will begin at an early date the construction of an irrigation work at one of the sites recommended by him. Apparently the most feasible project discovered by Mr. Reed is on the Hondo at a point nearly on the dividing line of the watersheds of Hondo River and the Black Water Arroyo. The reservoir site lies in a large natural depression, commonly called a dry lake, and has an area of 1,072 acres, and with no embankment would hold 11,486 acre feet. The bottom of the lake is a heavy alluvial deposit and borings were satisfactory as to its water-holding properties. The perimeter is nearly all limestone, and has the appearance of being as solid and free from cavities as any limestone formation, except at the places where fills are required. The sides are much higher than the proposed water line and have rock on or near the surface.

Mr. Reed's plan for diverting the water is to make two canals of sufficient size to carry all the flow of the river and to provide a spillway on the canal at a rock point 4,000 feet from the river. The river at the point of diversion is in earth, and to provide for a spillway here would be expensive and would be always a source of annoyance, if not danger. Two spillways or flushing gates are placed on the canal, each in solid rock, with their grade two feet below the grade of the canal at that point. These spillways are provided with gates, not automatic, for these gates are to be used only when the reservoir is full, or when it is desired to flush the silting basins. The top of the gates will be below the embankment grade, and will act as safety spillways in the case of unexpected and unusual floods.

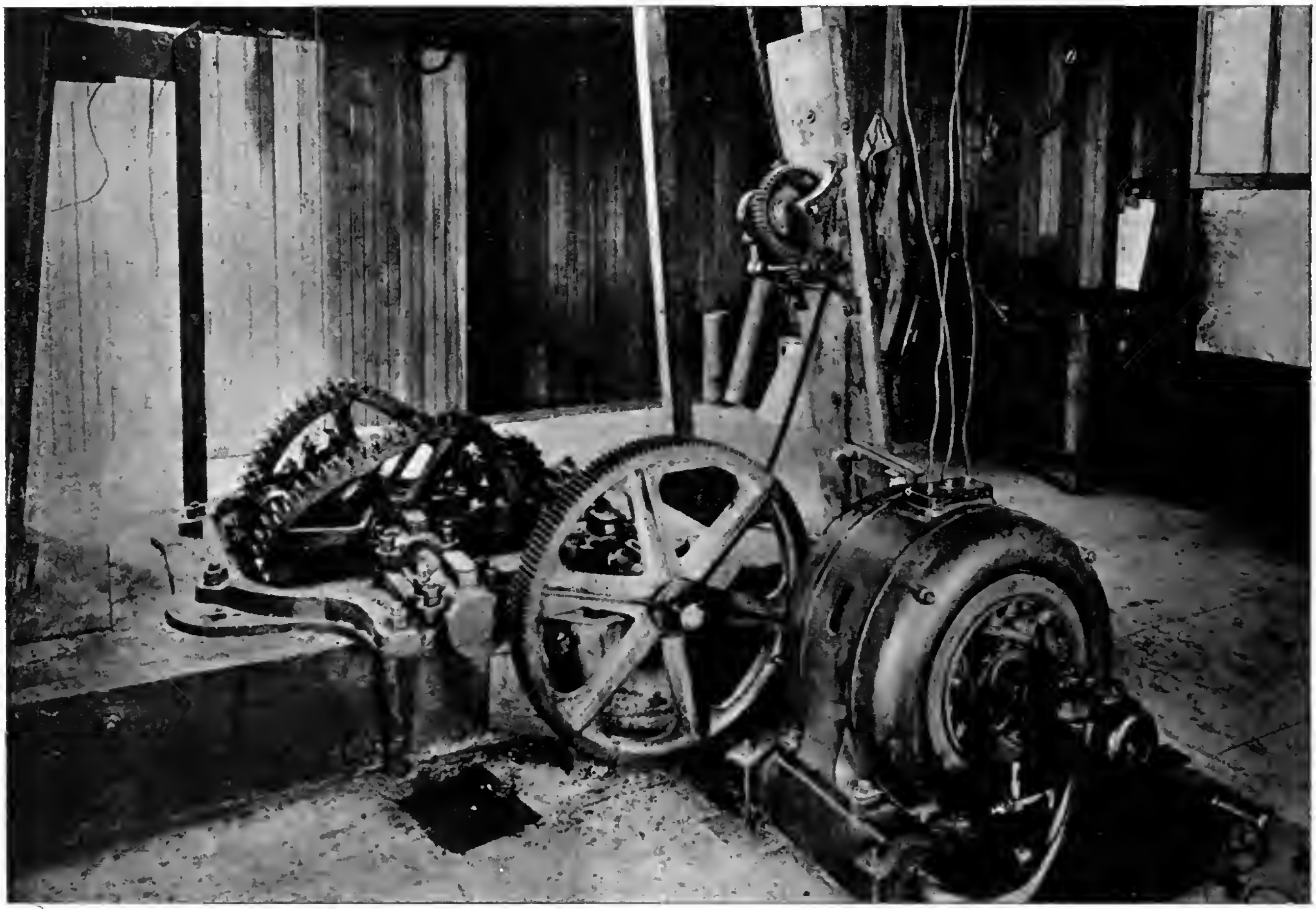
The canal will have a seventy-foot roadbed and an embankment will be placed at the lower side. The canal will enter the reservoir from a rock cut, thus preventing any erosion. The outlet canal will connect the lowest point in the reservoir site with the original bed of the river. The elevation at these points being the same, the canal is level.

PUMPING PLANT INSTALLED BY A. T. AMES IN ORCHARD OF JOHN BALLINGER, SAN JOSE, CAL., PUMPING 25,000 GALLONS AN HOUR AT 150-FOOT LIFT FROM A 12-INCH BORED WELL.

The bed of the Hondo will be used for carrying the irrigating water for a distance of about one mile. At this point it will be turned by a small concrete diversion dam into distributing canals on one side of the river. This point of diversion is not the most suitable from an engineering standpoint, but up to the present time one of the owners of the flood water rights having a ditch just below it has refused to make any satisfactory proposition toward a settlement with the Government in case the reservoir should be constructed, and it was deemed best to locate the canals from the above point to determine what lands would come under irrigation, and to ascertain the cost of the works. Diversion from

a point lower down the river would lessen the cost and would bring the same lands under cultivation.

During floods the Hondo carries a large amount of silt. Engineer Reed proposes the following plan to prevent danger of the reservoir filling from this source. The velocity of the canal is to be governed to such an extent that the heavier silt will be deposited in basins which are provided by making the alignment of the canal to cross three arroyos near their mouth where the surface flattens out. Two of these arroyos have a length of five or six miles and drain considerable territory. At the end of the basins at the down-stream side a spillway will be placed in the bank of the canal with a bottom grade below that of the canal. At times of heavy rainfall, when water rushes down the arroyos, the spill or flush-gates will be opened and the silt removed from the basins. The water passing through these flush gates will spread out over the bottom land and ultimately reach the old bed of the river, and can be sluiced down the river in the same manner that nature has been doing for ages. Except during the flood time the Hondo water carries very little silt, and therefore during the non-irrigating season, when there is a constant flow in the river, it is advisable to pass the water through the canal and into the reservoir with as little exposure to seepage and evaporation as possible. To be able to do this at one time and also at other times pass a little body of water through as a slow current, it is proposed to place a removable bulk-heading or gates below the sluiceways and thus be able to delay or check the current, causing the silt to settle in the basins. A. L. I.



NO. 3. AMES PUMP DRIVEN BY ELECTRIC MOTOR, DIRECT CONNECTED.

IRRIGATION WORK IN OREGON.

PRELIMINARY INVESTIGATIONS BY ENGINEER JOHN T. WHISTLER IN FIVE COUNTIES IN THAT STATE.

[*Special Correspondence of Irrigation Age.*]

WASHINGTON, D. C., Jan. 15.—Mr. John T. Whistler, engineer, United States Reclamation Service, reports as follows on the work done in Oregon:

Preliminary investigations were made through Umatilla, Baker, Malheur, Harney and Crook Counties in March and April. Three projects appeared to justify further investigation. A brief description of each of these projects, showing work done this year, follows:

Bordering on the Columbia River and west of the mouth of Umatilla River lies between one and two hundred thousand acres of uncultivated, rolling bench land at an elevation of 400 to 600 feet above sea level. A line of levels was run early in the season which showed the impracticability of taking water from either the Columbia or Snake River to put on this land. The summer flow of the Umatilla River, except early in the season, is all taken now for watering the Umatilla bottoms. Measurements of this river by the Geological Survey, covering a period of ten years, show that there is sufficient flood water to irrigate probably 100,000 acres if it could be conserved. Four gaging stations are now being maintained on this river and its tributaries. From May to August a small party was kept in the field developing possible reservoir sites on the upper waters of the Umatilla. Five sites were developed, but it is doubtfull if any of them will prove sufficiently inex-

pensive to justify further investigation. From September to December a double plane table party was kept in the field. A good reservoir site has been developed in townships 3 north, 25 and 26 east. Topography on a scale of 1,000 feet to 1 inch.

About twenty-five miles of canal line, with topography on scale of 400 feet to 1 inch has been run from this site to Umatilla River, and also about twenty miles of main lateral, with topography on same scale. No estimates have yet been made. More than half the land is unpatented, and most of the remainder is unimproved Northern Pacific grant land.

THE MALHEUR PROJECT.

Between the vicinity of Vale and Snake River, both on the north and the south side of the Malheur River, is some 40,000 acres of best bench land. It is mostly unpatented or road grant land and unimproved in any way. In addition, there are from 10,000 to 15,000 acres of bottom lands which are very productive, where not alkali. The summer flow of the Malheur River and all its tributaries in this region is now appropriated. Measurements of the Malheur River by the Geological Survey, covering a period of about eighteen months, indicate that there is abundant water to irrigate this land if it can be held till needed. Two reservoir sites of sufficient capacity to retain all the flood waters have been developed on the Malheur River. Two have been developed on Bulty Creek and one on Willow Creek in order to estimate on covering lands found to lie above the reservoir sites on the Malheur. Topography of these sites has been shown on a scale of 1,000 feet to 1 inch. Over fifty miles of canal line have been run and topography developed on a scale of 400 feet to 1 inch. Also about forty miles of preliminary lines without topography. A double plane table party has been in the field from May 1 to December 1. Gaging stations for continuing discharge measurements of streams connected with this project have been established on the Malheur River at Ontario, Vale and Harper Ranch, on Bully Creek at Warm Springs and on Willow Creek at reservoir site in township 14 south 41 east.

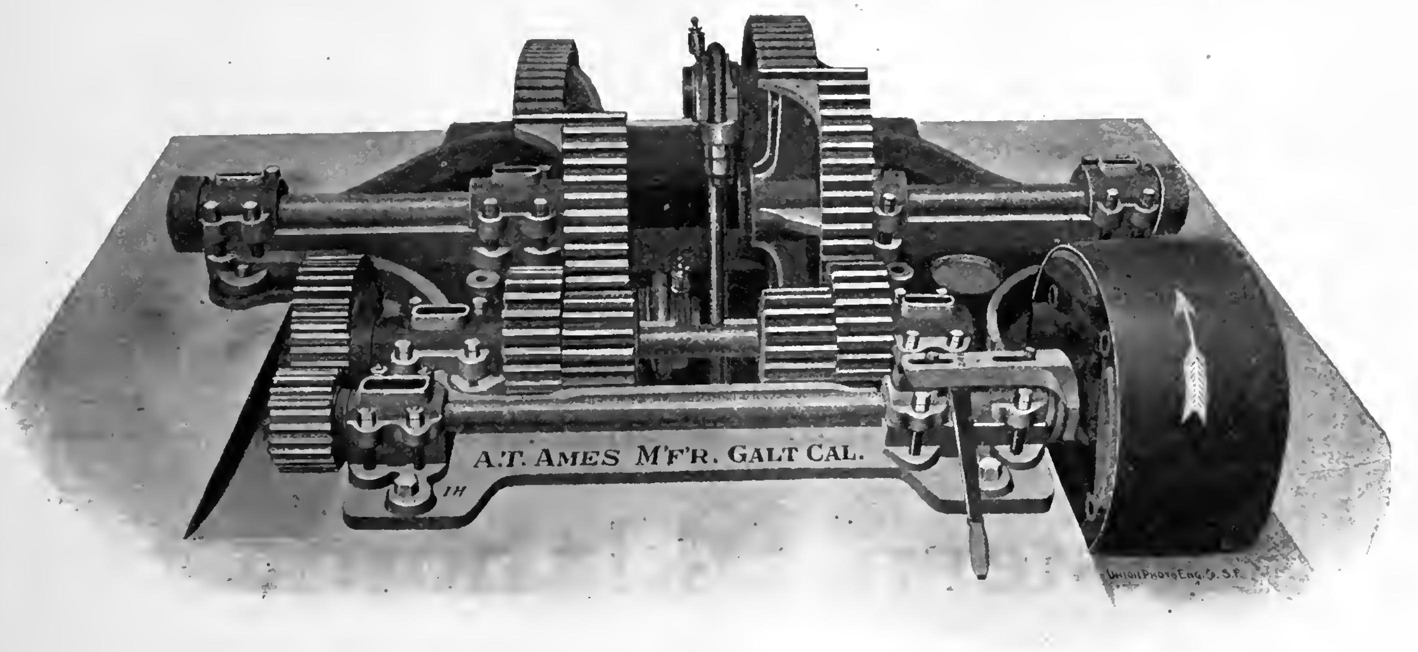
THE HARNEY PROJECT.

Harney Valley is a circular basin, more or less irregular, of about 700 square miles. It has an altitude of about 4,200. Harney and Malheur Lakes are in the lowest part of the valley and have no outlet. Much of the bordering lands are tule swamps. The valley slopes generally from north to south. Most of the lands of the valley have been patented in one way or another, and there are at present but about 100,000 acres unpatented. Practically all of this has been selected by the State under the Carey Act, but has not yet been approved by the Department. Silvies River enters the valley from the north. No measurements have been made prior to this summer, and very little is known regarding either the run-off or the precipitation in the Silvies basin. It seems hardly probable that more than 50,000 acres can be irrigated from it. A great deal of hay land is at present dependent on the flood waters for crops, and adjustment of water rights will unquestionably be attended with many difficulties. It is thought that the water from Emigrant Creek, which carries almost if not as much water as Silvies River proper, may satisfy these bottom lands. An excellent reservoir site has been developed in Silvies Valley, some twenty miles north of Harney Valley. A double plane table party has been in the field from May 1 to November 10. The reservoir —about twelve miles long—was developed on a scale of 1,000 feet to 1 inch.

Most of the irrigable land in Harney Valley—about 350 square miles—has been mapped and topography shown on a scale of 2,000 feet to 1 inch, with $2\frac{1}{2}$ feet contour intervals.

No estimates have been made on any of the projects considered. Preliminary investigations have been made in Wallowa, Lake and Klamath Counties. Gaging stations have been established on the Wallowa River, Grande Ronde River and the Owyhee River, looking to future investigations. Stations are also being established on Klamath River and other streams of Klamath County.

B. J. D.



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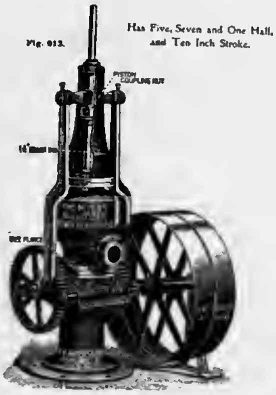

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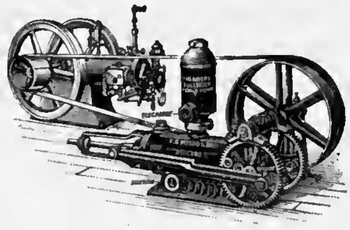

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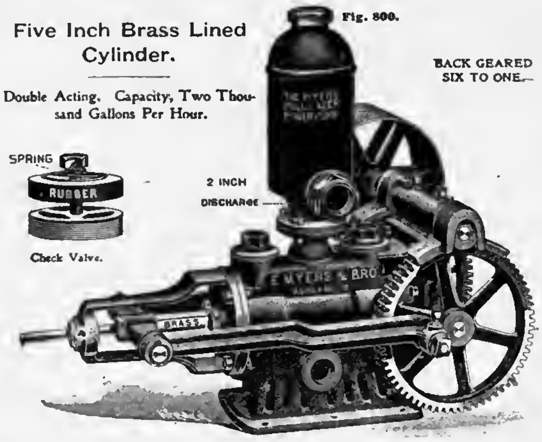

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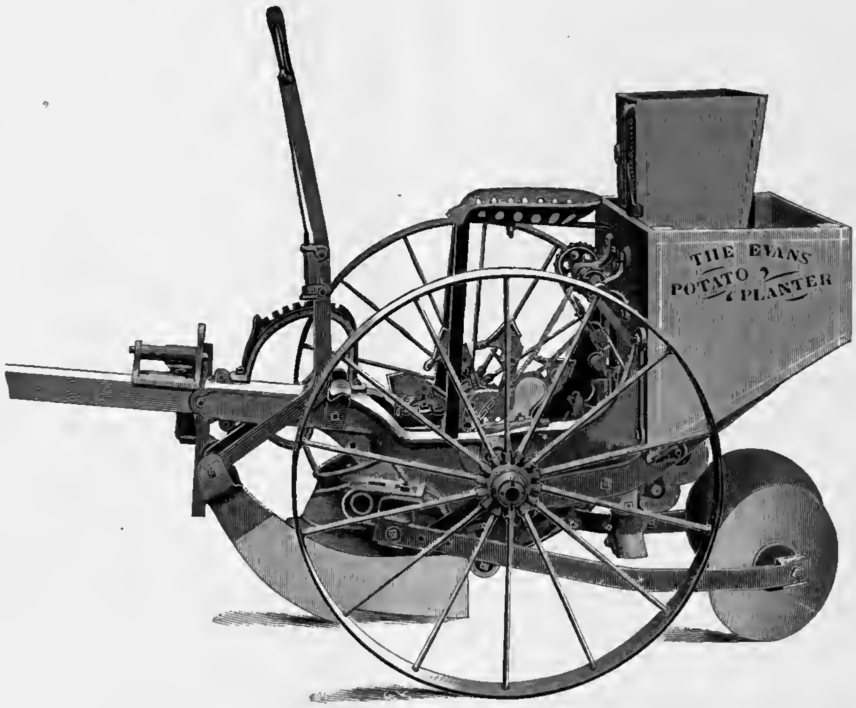

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THE IRRIGATION AGE

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EDITORIAL

ANNOUNCEMENT.

Absorbs Modern Irrigation.—Modern Irrigation, of Denver, the oldest publication next to THE IRRIGATION AGE devoted to irrigation interests, has been purchased outright by the D. H. Anderson Publishing Company, of Chicago, publishers of THE IRRIGATION AGE. *Modern Irrigation* is the successor of the *Irrigation Era, Arid America, Mid-West* and the *Farm Herald,* Denver. The business and subscription lists of *Modern Irrigation* have all been taken over by THE IRRIGATION AGE. All advertising contracts will be filled by this paper, and THE IRRIGATION AGE will be sent to all subscribers of *Modern Irrigation* until the expiration of their subscriptions.

The addition of the entire list of subscribers to *Modern Irrigation* gives THE IRRIGATION AGE a much larger circulation enjoyed by all the combined magazines and papers published in the interest of irrigation in the United States makes it the strongest publication of its kind in the world; in fact, it is the only thorough representative devoted to irrigation interests that is now published.

The addition of the large list of subscribers belonging to *Modern Irrigation* will be of great benefit to advertisers in THE IRRIGATION AGE, as it now covers very thoroughly the entire field. Advertisers can reach all interests connected with their business through THE IRRIGATION AGE more satisfactorily than by all other mediums.

To Fix Responsibility. Senator Hansbrough, Chairman of the Senate Public Lands Committee, in an interview with the representative of THE IRRIGATION AGE, tells in a very few words the simple object of his bill providing for the appointment for a chief engineer of the Reclamation Service. The bill is aimed at nobody and is not intended to interfere with the legitimate duties of any official of the Government nor is it intended to do any one any harm. It is only a wise provision to protect the interests of the people of the States in which the Government is to carry on its great work of reclaiming lands and to fix the responsibility for this work. As the reclamation bill now stands, this responsibility is not very clearly defined. The work is divided between the Secretary of the Interior, the Chief Engineer of the Reclamation Service and other officials. The Secretary of the Interior is not an engineer, and while the Chief Engineer has great powers he is not clothed with final authority in matters involving the expenditure of millions of dollars, so that the service as at present organized is in rather a loose and unbusinesslike condition without a responsible head. The appointment of a Chief Engineer with the proper authority will not only protect the interests of the Government, but of the people who are to be benefited by the work of the reclamation bureau and add immeasurably to the efficiency of its work. It is a good bill and has recieved the endorsement of a large number of the members of both houses of Congress. It ought to pass.

Milk in the Cocoanut.

It has been a matter of much speculation as to why certain interests, particularly those nearest some of the large railway systems which have no land grants, are so vigorously advocating a repeal of the land laws. It is well understood why those roads that have land to sell want the Government land taken from public entry, as in that case prospective settlers would be compelled to avail themselves of the five-year-resident requirement in order to obtain a home, or buy their land from the railway companies and large corporations who would be the only owners of other available lands. The explanation of the activity of the interests allied with the non-land grant roads may be found in the fact that they hold enormous amounts of scrip which may be used to acquire millions of acres of valuable land adjacent to their line.

Senator Gibson, of Montana, who is recognized as the representative of the Great Northern Railway, is vigorously urging the repeal of the land laws, although if the repeal bill becomes a law it will withdraw from settlement practically all the lands along that road in Montana. It would certainly place beyond the reach of the settler those vast areas of agricultural lands adjacent to the Great Northern Railroad in the vicinity of Senator Gibson's own home. No man in the country has done more than James J. Hill, president of the Great Northern Railway, to develop the resources of that great stretch of country which before the advent of his lines was a barren waste. His courage and far-sighted wisdom in pushing lines of his road up through the frozen prairies of North Dakota and westward over the barren plains of Montana and Idaho through to the Pacific coast, transforming them into prosperous areas and opening up hundreds of thousands of acres to settlement has aroused the admiration of the world and marked him as one of the most progressive and useful men of the nation. It is hard to believe, therefore, that Senator Gibson is deliberately seeking to withdraw the land along the road of the Great Northern in Montana for the purpose of preventing their early settlement. It is barely possible that somebody who is closely allied to Great Northern interests holds a large amount of scrip which is intended to be used to acquire these lands after they have been withdrawn from settlement and thus control their disposition.

Oregon Irrigator.

The Oregon Irrigator is the euphonious title of a new paper devoted to irrigation and published at Irrigon, Ore. The name of the paper, town and state are so suggestive of water that one instinctively feels like putting up his umbrella. *The Irrigator* is a vigorous exponent of irrigation and is putting in some good licks for Morrow County as an ideal place for fruit growing and general farming.

Decision as to Underground Waters.

The Supreme Court of California has rendered a very important decision in an action by the owner of an artesian well to enjoin a neighbor from operating wells for the purpose of supplying water to a distant tract by which the flow of the first wells was stopped. The court held that the diversion and sale of the underground water was an injury to the plaintiff which the courts would prevent, and this decision has been reaffirmed after another hearing.

The general principle laid down by this ruling is one of great importance not only to California, but to all countries where artesian wells are used for irrigation. This decision abandons the common law doctrine that the owner of land has an absolute right to all the waters lying underneath it, to dispose of them as he pleases without regard to the rights of adjoining property owners. The point of the decision is that a land owner who has used percolating waters upon his land has paramount rights to those of a subsequent appropriator who takes the water to distant lands. Another important point is that a land owner who is using artesian or underground waters will not be permitted to stop the flow of his wells by drawing off the water for sale. If he is using the water for irrigation, he is not entitled to a larger quantity than is necessary for his own use.

The decision, which is delivered by Justice Shaw, refutes the idea that might is the only protection to property owners and quotes these lines:

"The good rule
Sufficeth them, the simple plan,
That they should take who have the power,
And they should keep who can."

The decision thoroughly protects the right of a land owner to the uninterrupted use of the waters under his own land for the purpose of making that land productive and will not allow an avaricious neighbor at a distance to deprive him of it. The sound logic and hard common sense contained in this ruling will be commended by all honest men everywhere.

The McCumber Bill.

Some of the arid States are disposed to find fault with Senator McCumber's bill on the ground that its requirements are unscientific and illogical and would greatly delay the work of the Government where it is most needed at this time. The trouble is not so much with the provisions of Senator McCumber's bill as with the provisions of the reclamation act itself. Under the law, the States which have contributed the least amount of money to the reclamation fund are likely to receive the greatest amount of benefit from it. For instance, Nevada, which has contributed only $35,-000 to the fund, is the most arid State in the West and the Government work now in progress in that State will amount to $1,500,000. North Dakota, which has con-

tributed $2,456,000 from the sale of its land, will be benefited very little by the work of the reclamation service and in fact no plans have yet been devised or even seriously thought of for work in that State. Senator McCumber's bill is evidently intended to bring about a more even distribution of the enormous fund already amounting to over $16,000,000 and to secure to those States that have contributed large sums greater benefits than are now possible under the reclamation act. The people of Colorado are active in opposing McCumber's bill, for they fear that, should it become a law, it may interfere with the work on the Gunnison project, which is to cost about $2,000,000, and actually prevent, for many years at least, work in any other section of the State.

Bad Proofreading.

Mr. Willis T. Beardsley, of the Proceedings Publishing Co., of Ogden, which is printing the proceedings of the last irrigation congress, writes us that he is deeply pained because THE IRRIGATION AGE said last month that members of the congress were expected to pay for a copy of the proceedings. Like General Buller and Admiral Alexieff, Mr. Beardsley is filled with "regrets." He "regrets" that an impression that anybody should pay for a copy of the proceedings should get out because his arrangement with Mr. Keisel "calls for one copy postpaid to the address of each delegate." This is good news, but nobody would have guessed it from the circular that Mr. Beardsley and his partner, Gilbert McClurg, sent out in regard to these proceedings. Mr. Beardsley further "regrets" that "the circular is somewhat misleading in this regard and occurred through careless proofreading." He also "regrets" that "there are some errors in it, as you will note." Really, Mr. Beardsley and his partner, Mr. McClurg, ought to issue another circular correcting the mistakes of the first. Mr. Beardsley does not admit that it is a mistake that the Proceedings Publishing Company is boning everybody for advertising at $50 a page and begging ambitious gentlemen to have their portraits published at so much per. The National Irrigation Congress can much better afford to print its own proceedings hereafter than to have its name put to such base uses.

John P. Irish calls attention to one omission in Senator Hansbrough's bill, which he thinks may imperil the irrigation work of the Government. Mr. Irish believes that the income from the marketed resources of timber and stone lands as provided in the bill should go into irrigation directly by adding them to the irrigation fund, or indirectly by devoting them to the administration of forest reserves to protect the water sources from impairment. We agree with Mr. Irish that it will be well if the campaign against the irrigation income stops at the conservative measure of the Senator from North Dakota.

Mr. Pinchot on a String.

Gifford Pinchot, Forester of United States, is one of the most prominent social figures in Washington. He enjoys the confidence of President Roosevelt perhaps as much as any other man in public life. He is rich, having inherited some millions, a bachelor who knows Washington society thoroughly and who is forever in the eye of designing mothers of marriageable daughters. He understands the business of forestry, however, and loves the work. The Government gives him a barrel of money to spend in his department every year and he has wide liberty to exploit his theories about forest planting and forest saving.

Mr. Pinchot is a guileless young man, however, in many ways and has a reputation of being easily manipulated by designing men. Just now he is the special object of the attentions of that devoted band of gentlemen who want the land laws repealed for the benefit of future generations, and incidentally for themselves. The Press Bureau, which is supported by the contributions of the land corporations, has recently sent to all the newspapers of the United States a long article of fulsome praise of Mr. Pinchot's peculiar genius as a forester. Along with this delightful bit of journalistic imagery, the manager of the bureau couples an offer of Mr. Pinchot's photograph in a characteristic pose, that of a man who is thinking deep, hard thoughts, which the newspapers have had made into a cut at their own expense.

All this is well enough, but the pity of it is that the Press Bureau through a subtle and skillful manipulation of the article, makes it appear that Mr. Pinchot is the special champion of their plans and is in full sympathy with all of their schemes to take from settlement the millions of acres of available lands now open. They quote him as supporting their efforts to repeal the timber and stone act and make it appear that as the representative of President Roosevelt and the Government itself, he is in hearty sympathy with all of the underhanded work that is being done by the combination. On another page of this issue of THE IRRIGATION AGE is a reproduction of the letter that was sent out under the auspices of the National Irrigation Association under which the land corporations do business. It was intended as an alluring bait for newspaper men, but so far as our press clipping bureau has informed us, only one paper, a farm weekly with a circulation of perhaps 600 in far-off Massachusetts, has even nibbled at it. It is really too bad that a man of Mr. Pinchot's recognized ability and social accomplishments and influence should allow himself to be made a cat's paw by this unholy combination of land grabbers. Indeed it is to be doubted whether the chief forester himself is aware of the uses to which his name and position are being put by these enemies of the public good.

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Glover Building, 1419 F Street N. W.,

Guy E. Mitchell, *Secretary*, Washington, D. C.

SAVE THE FORESTS STORE THE FLOODS

WASHINGTON, D. C.

Note.

If you can use the enclosed article and will so advise me at once, I can send you a good newspaper cut of Mr. Pinchot, made from a late photograph.

Guy E. Mitchell

G. E. M.

Goes to no other paper in Chicago and is offered free of charge

"Scratch my back and I'll scratch yours."

FOR A SUPERVISING ENGINEER.

Senator Hansbrough's Bill Providing an Important Officer for the Reclamation Service.

On January 4 Senator H. C. Hansbrough, of Minnesota, chairman of the Senate Public Lands Committee, introduced a bill to provide an engineer to supervise the work of irrigation which the government is about to undertake. Senator Hansbrough has been bitterly assailed by the Press Bureau of the repealers and the corporations for thus daring to "interfere" with their plans as they expect to carry them out through Engineer Newell of the Reclamation Service. A representative of THE IRRIGATION AGE interviewed Senator Hansbrough in Washington as to the purpose of the bill and why there should be any objection to it.

"The purpose of the bill which I introduced, providing for the appointment of a supervising engineer in the reclamation service of the government," said the Senator, "is quite fully expressed in the bill itself, a copy of which I herewith enclose. The Government of the United States is just entering upon a policy involving the construction of great irrigation works. These works will consist of enormous dams and extensive canals. It must not be considered as any reflection whatever upon the present reclamation service when I say that the Congress of the United States feels that nothing should be left undone to secure the most perfect results, especially in the matter of construction.

"This generation is under a great responsibility for the safety and happiness of future generations. Fifty or one hundred years hence there will doubtless be an enormous population dependent upon irrigation established and controlled by the Federal Government. If it should occur that any of the great dams which are soon to be constructed were not properly built, both life and property would be in danger. Speaking for myself, I think it is no more than right that we should take the necessary precautions now and guard against the possibility of catastrophes such as I have already suggested. There are many bright young engineers now connected with the reclamation service, and, under the irrigation law, the Secretary of the Interior is authorized to call to his aid such consulting engineers as he may deem necessary. I do not recall that any Secretary of the Interior, who has held office since I have been in Congaess, has been a civil engineer. It follows, therefore, that, in the employment of consulting engineers, the Secretary must be guided by the engineers in the reclamation service. I think it far better that there should be one scientific head to the construction department of the service, and that he be placed under proper bonds and paid a sufficient salary to secure the best results.

"That is all there is to the bill, and the only purpose I have in introducing it. Several of the leading members of the Senate and House have personally urged me to press the measure to passage, which I hope to do at the present session."

SENATOR HENRY CLAY HANSBROUGH.

Senator Hansbrough is chairman of the United States Senate Committee on Public Lands and one of the most energetic advocates of irrigation in public life. Senator Hansbrough formerly lived in California and went to Dakota in 1882 when that state was then a territory. He was elected a member of the Lower House of Congress in 1889 and was elected tothe Senate in the winter of 1901 and 1902. He has always served on important committees in both houses of Congress and his influence on all matters pertaining to the development of the West is very great. A copy of his bill providing for a supervising engineer to take charge of the proposed irrigation work of the government and his explanation of its meaning is published in this issue of THE IRRIGATION AGE.

FULL TEXT OF THE BILL.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President of the United States be, and he is hereby, authorized and empowered to appoint, by and with the advice and consent of the Senate, a supervising engineer, who shall be under the direction of the Secretary of the Interior, and who shall have immediate charge of all construction work under the Act of June seventeenth, nineteen hundred and two, entitled "An Act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands." That the salary of the said supervising engineer is hereby fixed at ten thousand dollars per annum.

TO MEASURE THE VELOCITY OF WATER.

Miner's Ditch, Weir Dam and Cross Section and Velocity Methods Described.

Measuring the flow of water so as to determine the velocity in feet per second is an interesting process which is accomplished by three different methods: The Weir dam method, the Miner's inch method and the method known as "Measurement by Cross Section and Velocity." The latter is only used when it is desired to approximate the water quantity and is not very accurate. The method is as follows:

MEASUREMENT BY CROSS SECTION AND VELOCITY.

Select a stretch on the stream or ditch which will afford as straight and uniform a course as possible. If the water is at any point carried in a flume it is better to measure at this point. Lay off a distance of, say, 300 feet; measure the width of flowing water at about six different places in this distance, and obtain the average width; likewise at these same points measure the depth of water at three or four places across the stream, and obtain the average depth. Next drop a float in the water, noting the number of seconds it takes to travel the given distance. From this can be calculated the velocity of the water in feet per second. The quantity is the product obtained by multiplying the average width in feet by the average depth in feet by the velocity which (if in feet per second) will give the flow of the stream in cubic feet per second. From the figures so obtained it is advisable to deduct about 20 per cent, as surface velocity of the water is in excess of the actual average velocity.

When the stream is of sufficient depth—three feet or over—the average velocity can be more closely obtained by using a pole, to one end of which is attached a stone or piece of lead of necessary weight to allow the pole to sink nearly to the bottom. In this way the velocities at the surface and the bottom of the stream counteract one another and a closer approximation of the average velocity is obtained.

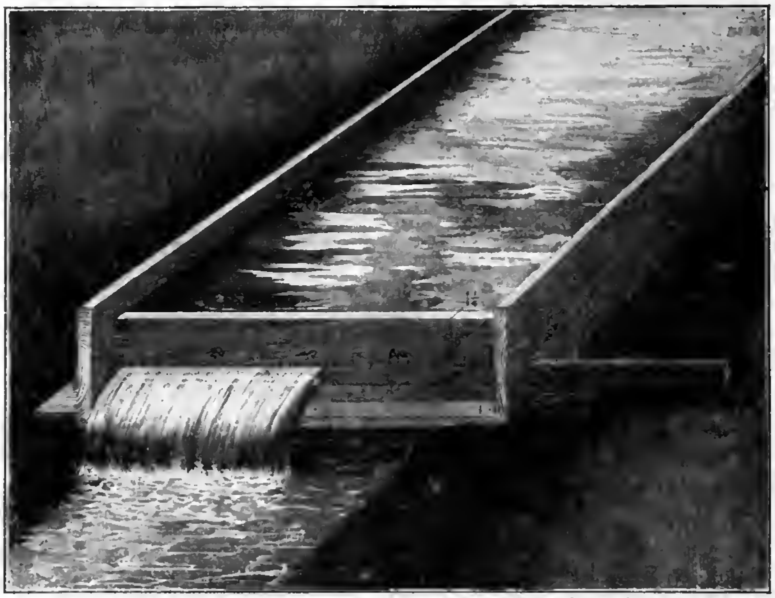
THE WEIR DAM METHOD.

To measure by the Weir dam method is the most accurate and reliable and should be employed for close calculations. It is as follows: Place a board or plank in the stream, as illustrated, at some point which will allow a pond to form above. The board should have a notch cut in it with its edge beveled toward the intake, as shown. The length of notch should be at least four times its depth for small quantities, and longer for larger quantities. In addition to the above it is advisable for very accurate measurements to have, when possible, the length of the notch about two-thirds of the width of the water on the up-stream side; it may be necessary to experiment somewhat in order to obtain this condition.

The overfall or vertical distance the water falls on the down-stream side should be about twice its depth—that is, twelve inches if the notch is six inches deep, and so on.

In the pond not less than three feet, and preferably six feet, from the weir, drive a stake near the bank, with its top precisely level with the bottom of the notch in the weir; then measure carefully with a rule the depth of water over the stake. This will give the theoretical depth of flow, corresponding to that in the table on this page.

In order to obtain accurate results it is essential that the velocity of water in the pond be extremely slow, and if the weir be constructed of proper proportions this condition will exist.



EXPLANATION OF MINERS' INCH MEASUREMENT.

The following table for weir measurement gives the cubic feet of water per minute that will flow over a weir one inch wide and from ⅛ to 20⅞ inches deep.

For example: Suppose the weir to be sixty-six inches long, and the depth of water on it to be 11⅝ inches. Follow down the left-hand column of the figures in the table until you come to eleven inches. Then run across the table on a line with the eleven until under five-eighths on the top line, and you will find 15.85. This multiplied by sixty-six, the length of weir, will give the result.

TABLE OF WEIR MEASUREMENTS, GIVING THE CUBIC FEET OF WATER PER MINUTE THAT WILL FLOW OVER A WEIR FROM ⅛ TO 20⅞ INCHES DEEP.

INCHES.		⅛	¼	⅜	½	⅝	¾	⅞
0.......	.00	.01	.05	.09	.14	.19	.26	.32
1.......	.40	.47	.55	.64	.73	.82	.92	1.02
2.......	1.13	1.23	1.35	1.46	1.58	1.70	1.82	1.95
3.......	2.07	2.21	2.34	2.48	2.61	2.76	2.90	3.05
4.......	3.20	3.35	3.50	3.66	3.81	3.97	4.14	4.30
5.......	4.47	4.64	4.81	4.98	5.15	5.33	5.51	5.69
6.......	5.87	6.06	6.25	6.44	6.62	6.82	7.01	7.21
7.......	7.40	7.60	7.80	8.01	8.21	8.42	8.63	8.83
8.......	9.05	9.26	9.47	9.69	9.91	10.13	10.35	10.57
9.......	10.80	11.02	11.25	11.48	11.71	11.94	12.17	12.41
10.......	12.64	12.88	13.12	13.36	13.60	13.85	14.09	14.34
11.......	14.59	14.84	15.09	15.34	15.59	15.85	16.11	16.36
12.......	16.62	16.88	17.15	17.41	17.67	17.94	18.21	18.47
13.......	18.74	19.01	19.29	19.56	19.84	20.11	20.39	20.67
14.......	20.95	21.23	21.51	21.80	22.08	22.37	22.65	22.94
15.......	23.28	23.52	23.82	24.11	24.40	24.70	25.00	25.30
16.......	25.60	25.90	26.20	26.50	26.80	27.11	27.42	27.72
17.......	28.03	28.34	28.65	28.97	29.28	29.59	29.91	30.22
18.......	30.54	30.86	31.18	31.50	31.82	32.15	32.47	32.80
19.......	33.12	33.45	33.78	34.11	34.44	34.77	35.10	35.44
20.......	35.77	36.11	36.45	36.78	37.12	37.46	37.80	38.15

GREAT WORK ON LAVACA BAY.

Irrigating Plan in Texas to Convert It Into Fresh Water Lake.

An irrigation project that will be the largest in the rice region of Louisiana and Texas, and certainly the most extensive that has ever engaged the attention of capital in the State of Texas, is the one that involves the construction of a dam that will convert the entire upper part of Lavaca Bay into a huge fresh water lake. and which has engaged the attention of promoters and railroad companies for the past year.

It is not certain that work on this great enterprise will commence this year, says the Port Lavaca *Wave*, but it is a fact that the project has been duly investigated and passed upon by engineers and maps and other drawings made and estimates of the cost of constructing it given, and that it has been duly accepted as practical.

That the dam will be built some day is assured, and it is also no dream to say that the dirt may fly before many moons shall pass away.

WEIR DAM MEASUREMENT.

The proposed dam is to extend from Noble's Point on this side of Lavaca Bay across the narrows to Mitchell's Point on the east side. The bluff on each side is over twenty feet above tide level. Above these two points the bay spreads out, and the dam will create a lake of over 25,000 acres and be fifteen to eighteen feet deep. It will also retain the water in the Lavaca and Navidad Rivers and in the Garcitas, Placedo and other large creeks, and create a series of smaller fresh water lakes and afford the means, according to the engineers' estimate—facts concerning which are coming out—to irrigate fully 300,000 acres of rice land. The lands to be irrigated are in Jackson County, between the Navidad River and Caraneahua Creek, and include large portions of Calhoun and Victoria Counties.

Estimates have been made of the cost of a dirt dam faced with stone and a full stone dam, including locks permitting the passage of vessels and spillways providing for the overflows in time of heavy rains in the back country. The cost of constructing the dam will not be great when it is considered that there is a single project in the West, headed by Senator Clark, the Montana multi-millionaire, that will involve the expenditure of $15,000,000, and that there are other single projects in the great arid belt that will also require many millions, and not one of which will irrigate as much land as this Texas project. The total costs of the huge projects to reserve the stream water in the West for agricultural purposes is put at $160,000,000 by the best authorities. Then Uncle Sam is to be called on to put in his mite and swell the figures to bewildering proportions.

But it pays, and the projects, one by one, will be completed, and Texas is merely falling into line. It is not only a fact that the Lavaca Bay project will cost less than any single one of the large enterprises of the West and will irrigate more land, but it can be used by the railroads for tracks across the waters, saving long distances; in fact, the railroad interests are allied with the irrigation forces in promoting it. The proposed dam will be built across the bay a fraction less than two miles above Port Lavaca, and supplementing its irrigation benefits it will give the town the largest fresh water lake in the State of Texas, and affording fresh water as well as salt water fishing and creating here the greatest seaside pleasure resort on the Gulf of Mexico.

STRAWBOARD INVESTIGATION.

The strawboard investigations conducted by the United States Geological Survey show that the relation of strawboard waste to water supply is particularly strained in the States of Ohio, Indiana and Illinois. The object of the investigation made by the Survey in Indiana was to bring the strawboard company to a realization of the fact that the enormous waste of the valuable cellulose which is carried away and causes trouble is unnecessary, and that pollution by strawboard waste can be removed if the method of strawboard manufacture is changed. The valuable materials which are now carried away in waste waters to the pollution of the streams may be retained and converted into strawboard.

WILL NOT BE STOPPED.

844 Main Street, Geneva, N. Y., Dec. 29, 1903.
D. H. Anderson, Editor Irrigation Age, Chicago:

Dear Sir—This is to notify you not to send me any more copies of The Irrigation Age, as I expect to die any week, having been paralyzed for a month already. I believe that I am one of your very earliest subscribers. I have read The Irrigation Age up to date with great interest, deeming it one of the most intelligent up-builders of our great West. As my strength decreases my faith in God (I speak reverently) and the future of The Irrigation Age increases.

Yours until "incineration."
Walter S. Church.

HISTORY OF PUMPING WATER.*

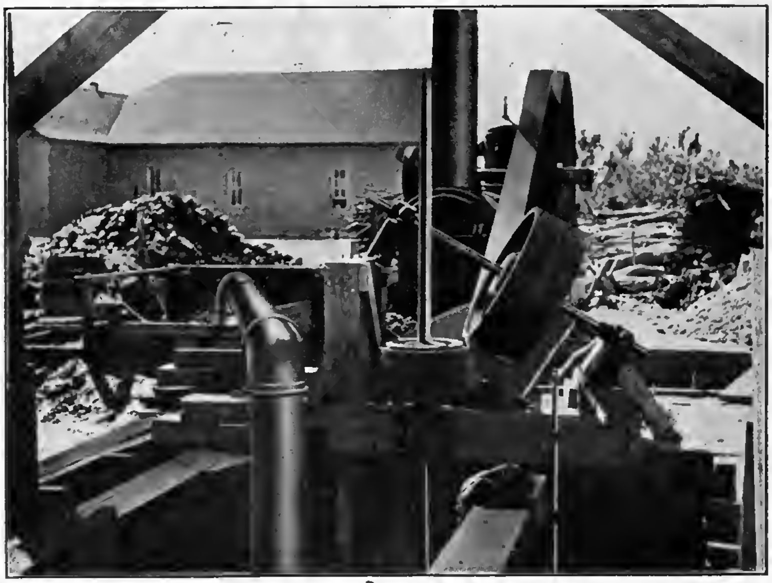
Wonderful Development of Plants for Irrigating Purposes and Their Use in New Mexico.

BY JOHN J. VERNON AND FRANCIS E. LESTER.
New Mexico College of Agriculture.

[Continued from January number of THE IRRIGATION AGE.]

By flushing out the well we mean the pumping out of the well to its limit of capacity in order to remove the sand intermingled with the gravel around the strainer. It is somewhat doubtful whether a well under our conditions can be so thoroughly flushed out that no more sand will appear in the water.

The necessity for flushing at all depends entirely upon the type of pump to be used later for pumping. Flushing is extremely desirable if a piston pump is to be used on any other type of pump having close fitting wearing parts. If a centrifugal pump or similar type is to be installed it is not necessary to go to the trouble or expense of flushing the well. Such a pump will not be injured perceptibly by the sand and it will do its own flushing, gradually removing the sand and thus leaving a porous gravel stratum around the strainer through which the water can find its way into the well freely.



SHOWING MANNER IN WHICH THE VAN-WIE AND KINGSFORD PUMPS WERE BELTED TO THE ENGINE BY THE USE OF AN IDLER.

POWER.

The question of the most economical power is of course a very important one in connection with the matter of installing a pumping plant. A brief discussion of this matter may therefore be of interest.

Wind and water constitute two of the cheapest sources of power. The use of the first of these does not appear to have been productive of very successful results in this territory. To begin with, the greatest wind movement during the year is in the spring season when, as a rule, water from wells is least needed. In those parts of the territory relying upon river water this source seldom runs short until the spring season is well passed and in these localities pumping for irrigation is not likely to be much resorted to at that time. During the summer months when the greatest need for water for irrigation purposes exists, there is much less wind movement than earlier in the year and it frequently happens that when the water is most needed there is the least amount of wind. The use of storage reservoirs to make more available the water pumped by wind power is open to the criticism of expense for the installation of such reservoirs, together with the high loss through evaporation if the reservoirs are open.

Water as a source of power is available in comparatively few parts of our territory. The question of developing power from our water courses and transmitting it by electricity to the locality where it is most needed has received some attention in the territory and may be of some use in connection with pumping plants for irrigation purposes.

Among the remaining sources of power are steam; oil, including gasoline, kerosene and crude oil; and horse power. The statistics shown in Table 11 will be of interest in a comparison of steam and oil on a basis of economy. The question of which is the most economical fuel must depend largely upon the conditions existing in each locality. In many parts of our territory wood and coal may be procured at relatively so low a cost that steam becomes by far the cheapest available power. It should be borne in mind in this connection that under average conditions a steam engine requires skilled labor to operate it, but, on the other hand, is considered one of the most reliable means of power and the least subject to breakdowns or getting out of order.

Gasoline heretofore has cost so much that the question of whether or not it will pay to use it at the present price for developing power for irrigation plants is still a debatable one. On the other hand, it will be noticed by looking at Table 11 that the majority of oil engines are operated by common and not skilled labor.

Crude oil as a means of power is being successfully used in various parts of the country. Mr. J. A. Smith, of El Paso, Texas, has recently installed a 28 horse-power, Fairbanks-Morse, crude oil engine which, although at the time these lines are written, has not been running for any length of time, is giving entirely successful results. An important consideration in the use of crude oil is the tendency that appears to exist of increased price of the oil. During the past six months the price of crude oil in the vicinity of El Paso has steadily advanced and a number of users of crude oil in that city have recently discarded it in favor of other fuel. The manager of the El Paso Water Works, under date of February 18th, writes in this connection as follows:

"The price of Beaumont oil has gone to $1.21 per barrel, El Paso delivery. This is equal to coal at $4.84 per ton and we can get coal at $4.50, so you see oil burning in El Paso and vicinity is a thing of the past. We have half our furnaces changed to coal now."

It is thus evident that, before installing a pumping plant, the owner should carefully investigate the cost of available fuel, including, of course, delivery charges on oil, coal and wood.

* From Bulletin No. 45 issued by the New Mexico College of Agriculture and Mechanic Arts, Mesilla Park, N. M.

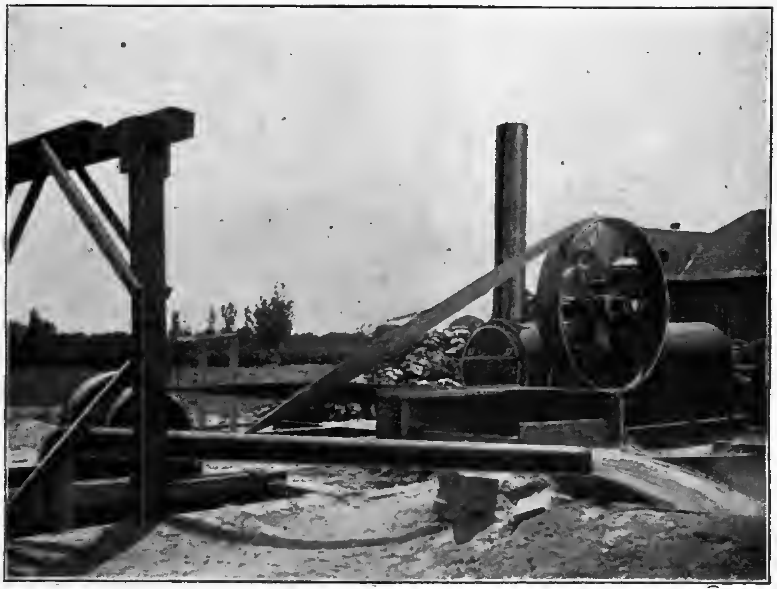
VARIOUS TYPES OF PUMPS.

"There are four distinct types of pumps—the plunger or piston pump, . . . ; the vacuum, the rotary, and the centrifugal, beside elevators which raise water by means of flights attached to an endless chain." Probably only the three last named types can be relied upon for cheap production of large quantities of water for irrigation by pumping. It is not the purpose of the writers, however, to enter into a lengthy discussion of the relative efficiency of the various types of pumps other than those under the test.

For our present purpose the efficiency of the pumps is reckoned upon the relative cost of lifting a given amount of water from the same well.

Centrifugal pumps having no close-fitting or complicated working parts, create comparatively little friction, are seldom or never out of order, and are not appreciably injured by sand or gravel in the water, yet in this type of pump there is a considerable loss of power by the slippage or play of the water upon the loosely fitting paddles.

Rotary pumps have close fitting working parts, which may or may not be of a complicated nature, with a relative increase in friction, and in the latter case are more difficult to keep in repair. But on the other hand the suction is positive and there is almost no loss of power by slippage of water upon the paddles, and thus result in a greatly increased efficiency. Sand must not exist in the water unless there is some method of taking up the wear upon the working parts.



DISCHARGE FROM A SIX-INCH PIPE BY THE R. S. WOOD CO.'S NO. 6 PUMP RUNNING AT 600 REVOLUTIONS PER MINUTE.

We are unable, at this time, to pass upon the durability of the pumps tested more than what may be said from the working of the pumps and from their individual appearance. There is little question as to the durability of centrifugal pumps. As to the rotary, with its cams and rollers to operate the pistons and springs to take up the wear, caused by sand, etc., to say the least, it will require greater intelligence and care in operating.

PUMPS TESTED BY THE STATION.

The pumps were tested practically under like conditions, namely, upon the same well; placed the same distance from the water level in so far as the form of the pumps would permit; with the same engine, a 20 horsepower steam engine and boiler (except where otherwise specified) with the same kind and amount of wood by weight, namely, one quarter of a cord, weighing 492 pounds, of small dry tornillo wood; under the same steam pressure, with a few necessary exceptions where the work was heavy; with the water level in the boiler practically the same; and with the same weir and apparatus for measuring the water discharged by the pumps.

The Van Wie Centrifugal Pump is of the vertical single top side suction, belted type, made by the Baldwinsville Centrifugal Pump Works, Syracuse, N. Y. A No. 5 pump with a 6-inch suction and a 5-inch discharge, fitted with a 6-inch suction and 7-inch discharge pipes, was tested.

Fig. 16 shows the manner in which this and the Kingsford, both vertical pumps, were belted to the engine by the use of an idler.

Fig. 17 shows the discharge thrown from a 7-inch pipe by this pump, running at a speed of about 750 revolutions per minute.

The results of the test are recorded in the following table:

Gallons per minute.	Speed of pump, revolutions per minute.	Time run on ¼ cord of wood (492 lbs).
600	455	2 hours 29 min.
824	515	1 hour 43 min.
944	530	1 hour 29 min.
988	540	1 hour 14 min.
997	760	

In answer to several correspondents who have made inquiries concerning the Iowa Drainage Convention held at Ames in January, we refer them to Prof. W. N. Stevenson, of the Agricultural College of Iowa, who will doubtless be glad to send all information regarding the convention that is requested.

MAP OF KENLY QUADRANGLE.

The United States Geological Survey, acting in co-operation with the Department of Agriculture of the State of North Carolina, has just published a map of the Kenly quadrangle in that State. Parts of Wilson, Wayne, Johnson and Nash Counties are included in the quadrangle, which has an approximate area of 245 square miles.

The sheet is important, as it shows the rise from the coastal plain on the east to the Piedmont plateau. The Atlantic Coat Line Railroad, which skirts this plauteau, crosses the quadrangle diagonally, passing through the towns of Lucama and Kenly. The country is generally low and swampy, the elevation ranging from 100 feet above sea level in several places to 294 feet near Connor.

The soil of this region is sandy and is adapted to the cultivation of tobacco and cotton. Cotton has been grown here extensively for a number of years, but the tobacco industry, which has developed very rapidly in the last few years, is comparatively young.

The map may be procured for the sum of 5 cents on application to the director of the Geological Survey, Washington, D. C.

IRRIGATION IN NORTH PLATTE VALLEY.

Progress of the Work in Nebraska During the Past Twelve Years.

BY W. H. WRIGHT.

[Read before the Nebraska Irrigation Association at Lincoln, January 21, 1904.]

My home has been in the Platte Valley since the spring of 1891, in the county of Scotts Bluff. Prior to this time most of the desirable lands in this and adjoining counties were filed on by a hardy and hopeful class of pioneers who made a strenuous struggle in keeping the wolf from the door, only to be defeated by the adverse elements, long continued droughts and occasional hot winds.

The first attempt at constructing an irrigation canal was in the season of 1887. In 1891 there were several small canals completed or under construction. Those completed gave very indifferent service, from lack of experience and knowledge in preventing sand from accumulating in the canals near the head-gates. These canals were constructed by the settlers under great difficulties, as the settlers were practically without capital or credit; but they had muscle, a limited supply of "bronchos" and an abundance of grit. What they accomplished under these difficulties, which would have appalled a less hardy class of persons, redounds to their everlasting credit.

As for my experience in raising crops under irrigation. Coming to Scotts Bluff County first in the interest of the promoters of the Farmers' canal, I found myself stranded in the year 1894, and forced to try my hand at farming under irrigation as a means of existence. That I am here is evidence of at least partial success. I have never suffered for lack of something to eat, but have always had an abundant supply of the finest vegetables raised anywhere in the United States; potatoes, onions, beets, squash, melons, asparagus, etc. For six years most of my income came from crops raised on less than ten acres. I have raised as much as 400 bushels of potatoes from an acre of ground; 800 bushels of onions, and 1,200 bushels of stock beets. I have raised melons which would rival those of Rocky Ford. I have also been engaged in raising stock hogs by running them on alfalfa pasture, and will say that this promises to become a leading industry in the valley, as the hogs raised there are exceedingly healthy. I have never known of a case of cholera in the country and it has been my experience that we can raise a hog to 250 or 300 pounds, 75 per cent of which can be credited to alfalfa. The best results can be obtained by feeding a small amount of grain with the alfalfa, which gives a balanced ration.

VIEW OF MORRIS PUMP AT WORK, MISILLA PARK EXPERIMENTAL STATION, NEW MEXICO.

I can hardly conceive of a better location for dairying enterprises than our irrigated districts afford; we grow a better quality of alfalfa hay than is grown in the rain belt; besides, we have a better climate for curing the hay. Well cured alfalfa hay supplemented with some kind of ground feed is a perfect ration for dairy cattle.

I do not remember of seeing any alfalfa fields during the first year of my residence in Scotts Bluff County, though several fields were seeded to alfalfa that season, since which it has come to be the main crop of the county. I esteem it the cheapest food crop on earth, yielding under good management from four to six tons of hay per acre per season. Added to its value as a feed crop is that of a fertilizer, of which I know no equal; it roots very deeply, acting as a sub-soil.

In the last few years I have noticed a great increase in the yields of small grains upon land broken up after having been seeded to alfalfa. The crop of oats after alfalfa has been from 60 to 100 bushels to the acre; wheat from 25 to 50 bushels, and other crops yield correspondingly. We raise some very good crops of corn after alfalfa, although the altitude is too high and the nights too cool for an ideal corn country.

Irrigated hay, known as wheat grass from its resemblance to bald wheat, is proving a profitable crop; this hay is much sought for work horses and has been shipped as far east as Boston. It requires only two-thirds as many cubic feet to make a ton as ordinary hay.

The development of agriculture in the semi-arid district by irrigation in our country is in its infancy. An irrigated country is especially adapted to intensive agriculture. The time is near at hand when the attractive agricultural district will be where the desert has been reclaimed by irrigation, and land will be more valuable there than anywhere else, largely from the outlay of capital and labor in developing its latent productive power.

And by the way, the intrinsic value of land is less than many people think. In a recent trip through Vermont, New York and Ohio, my attention was called to the immense expense the farmers were put to in securing fertilizers for their worn out soil. Eastern farmers have long been robbers of the soil. When a farm in the east is sold, the land enters very little into the consideration, as the farm seldom brings a price above the improvements, and often less. There is no reason why irrigated districts should ever be taxed to the extent the farmers in the east are in keeping up the fertility of the soil.

SELLS BIG CANAL TO FARMERS.

J. H. Brady Disposes of Water Rights in Willow and Sand Creeks, Idaho.

J. H. Brady, of Pocatello, Idaho, has just concluded one of the biggest transactions in canal property ever consummated in Idaho by the sale to a syndicate of farmers of all that portion of the Idaho Canal lying above Idaho Falls, including all water rights in Willow and Sand Creeks, for a consideration of $125,000. For five years prior to last February this property had been involved in litigation that retarded the settlement of the lands under it, and finally last February it was sold by order of the court to the highest bidder, Mr. Brady, as president of the Idaho Canal & Improvement Company, being the fortunate buyer at $100,000.

The system under Mr. Brady's original purchase was the largest in the entire arid West, comprising over 350 miles of canal and laterals. Under Mr. Brady's energetic management, several thousand dollars were expended in improving the system last year with the result that its capacity was greatly enlarged. This last transaction only disposed of about one-fourth of the property, the balance remaining in the hands of Mr. Brady and his associates. It is their intention to extend this part of the system across the reservation to Pocatello and reclaim rich agricultural lands which are to be put on the market by the Dubois bill now before Congress, and which will doubtless be passed on this session.

It is stated at the office of the company that this is a portion of the system that Mr. Brady became interested in in 1892 and to which he has been constantly adding ever since. At the time of this sale his company was operating one of Idaho's largest irrigating systems. This branch of the canal that was sold covers a tributary which properly belongs to the Farmers' Progress Canal Company and the consummation of this sale will place that company in a much better position to supply its customers, as it carries with it twenty thousand inches of water.

This still leaves the Idaho Canal & Improvement Company, Mr. Brady's property, with a very fine system of canals and laterals of something over 250 miles, with 80,000 inches of water, to supply its customers, which is supplied through two large hydrants on the main river. This is sufficient for the irrigation of all the lands that can be brought under cultivation under the canal between Idaho Falls and Pocatello.

This is a very fine property and is worth in the neighborhood of $600,000.

DISCHARGE FROM A 6-INCH PIPE BY THE KINGSFORD CENTRIFUGAL PUMP NO. 6 RUNNING AT 640 REVOLUTIONS PER MINUTE, AT MISILLA PARK, N. M.

GERMAN METHOD OF TILE DRAINING.

Dr. A. Golf, the Well Known Engineer, Describes Recent Important Invention.

Dr. A. Golf, of Bonn-Popplesdorf, Germany, sends THE IRRIGATION AGE, under date of January 14, the following method of tile draining by Jul. Kuehns. It will be of great interest in America, where it is as yet unknown:

"For all soils which suffer by too great height of ground water it is necessary to take away the noxious abundance of water, either by ditches or by tile drainage, in order to make agriculture profitable.

"But there are plenty of lighter soils with heavy subsoil little penetrable for water, which become so wet by abundant winter humidity that as well the winter seeds are injured as the tillage is much lengthened in spring, while during summer they dry up easily. If these soils would be drained, the noxious surplus of winter humidity would be carried off indeed. During summer, however, the soils would dry up still more than without drainage, and the larger part of the water of the spring and summer rains would be led off by the drain tiles and would be lost for production of plants.

"To create favorable water conditions to these soils largely spread over the North-German plains, Dr. Jul. Kuehn, the noted German agriculturist of the university at Halle, invented the following method: He employed the tile drainage, but with the variation of fitting out the main drains in regular distances with valves accessible from the surface, for the purpose of interrupting the drainage to one's liking by closing the valves.

"Jul. Kuehn stated by experiments that a constant raising of the surface of the groundwater to 60 cm. (27.6 inches) below the surface of the field makes no trouble, and that, without any damage, the groundwater can rise to 50 cm. (19.7 inches) below the surface for a short time. If thus the groundwater does not rise higher than 28 inches below the surface, it is profitable to save the water as much as possible for the use of the plants. The groundwater rising higher than 28 inches for only a few days, there is notwithstanding nothing to be feared, and only if the height of the groundwater ascends above 28 inches below the surface for a longer time (more than seven days), there must be taken care that the injurious surplus water runs off.

"Such a regulation of the height of the water in the soil is possible by means of *a tile drainage fitted out with valves.* Beginning winter, all valves are

opened in order to winter the fall seeds safely and to dry the fields still unsown as soon as possible in spring. In the first case, the valves are closed soon after thawing, in the latter they stay open, until the tillage is finished or until the surface is dried so much that teams can enter the acre, after that the valves are closed directly.

"That part of the winter humidity which is in the soil still, is prevented from running off through the drain tiles and is saved for the plants. Neither the water of the summer rains is lost and is retained for producing crops. If, however, heavy showers occur in the summer months and, on that account, the water rises too high in the tubes standing above the valves—higher than 28 inches below the surface for more than seven days—the valves are opened half an hour or one hour or few hours, until the surplus is run off.

"Laying out the ventil drainage, some important facts are to be considered. The main drains must obtain sufficient fall, therefore they must be located usually along the direction of the greatest fall. Only in this case it is possible to store the groundwater up symmetrically; besides it is to be considered that some fall is lost by fitting the drains with valves.

"The laterals must flow into the main drain from above, because on this method quicksand and other settled matter are washed away by the water most easily.

"The whole system of the valve drainage must be laid out with the greatest carefulness, because it is not destined to be emptied regularly and entirely, but to conditions very alternating between storing up continually and running off unhindered.

"It is advisable to cover by plates of clay the upper part of the joints made by abutting the ends of two tiles together. These plates are about 3.6 inches long, 2.4 inches wide and 0.6 inches thick. They are to be not too soft but nevertheless pliable in order to cling to the tiles. The plates prevent the roots from creeping and the particles of soil from being washed into the pipes from above.

"Concerning the valves, the pressed valves of Raumer (made by August Niemann, manufacturer of clay products, Flensburg, Germany), are most suitable for this purpose, because only little fall is lost by them. It is to be taken care that the valves close perfectly.

"It is very important to connect the valves strongly with the drain trace, the joints must be made tight by cement or similar substance. Upon the valve is set a clay tube and upon the tube is set a wooden box standing out over the surface 5 to 15 inches and supplied with a cover which can be locked. Only the main drains are fitted out with valves, not the laterals.

"The number of the valves is dependent from the fall conditions of the field to be drained, the greater the fall the greater the number of the valves. Laying out the first valve drainage in Germany, one valve was sufficient for about three acres.

"The valve drainage has only the one disadvantage that the wooden boxes of the valves standing out over the surface of the field make trouble in tilling and harvesting with machinery. But this small disadvantage disappears, considering the immense profit.

"Very large is the number of the fields which are too wet in winter but dry up in summer. On all these sandy or loamy-sandy soils, the valve drainage secures the fall seeds to winter safely.

RAISING POTATOES BY IRRIGATION.

At the New Mexico Experiment Station a preliminary test in potato growing was conducted by Fabian Garcia during the past season with the idea of finding out something about the best time to plant, best method of culture, as well as testing a large number of varieties. Two plantings were made, the first one on March 30, and the second on April 30. In each case part of the potatoes were planted in furrows and part of them on ridges. Those in furrows were planted about four inches deep and the furrow was plowed back on them, while those on ridges were put in with a garden trowel about the same depth. A few of the potatoes planted in furrows were covered with straw and then with dirt. Immediately after planting all were irrigated to start them to sprouting. The potatoes on ridges sprouted first and a good stand as well as a fair growth was secured. Those planted in furrows were slow and irregular in coming up and, on the whole, the stand was poor. In fact, the results from these potatoes were very unsatisfactory. The small-sized tubers and poor yield were due, to a large degree, to the soil packing so much around the plants after each irrigation. The cultivations given between the irrigations did not seem to help very materially to keep the soil loose in the middle. On the other hand, the potatoes on the ridges ripened earlier, during the first week in July, and the tubers grew to a fair size and the yield was good. The early planting did the best. On the whole the results of the early planting and ridge system of culture were very satisfactory and encouraging.

Out of the thirty-nine varieties planted the Rose Seedling, Triumph, Early Six Weeks, Early Ohio, and New Vermont Gold Coin did the best. These are all early varieties.

It seems from these results that early planting, ridge culture, and a suitable early variety are among the more important points to be considered in potato growing, at least in the Mesilla Valley.

BLOW AT SCRIP SYSTEM.

We are glad to see, after all these years of misdirected prerogative, that a resolution has been introduced in the Senate directing the stay of all proceedings now pending on any application to enter or patent even numbered sections of public lands in lieu of odd-numbered sections owned by any railroad within the limits of forest reserves created by legislative order. Railroad companies and individuals have been compelled to surrender public lands within the territories set aside by the President for forest reserves, and are selecting land outside of such reservations in place of the land surrendered. The resolution declares that railroad companies shall not receive as grants any even numbered sctions of public lands, and that all such sections shall be reserved for individual settlement. This is a whack at the scrip system that has been creating such havoc in equitable settlement of the West.—*Denver Field and Farm.*

A New Jersey inventor has discovered a plan to utilize mosquitoes. He calculates that one mosquito exerts fifty times as much suction power proportionately as the most powerful steam pump. All he needs is a mosquito big enough, and there you are.

THE PRIMER OF IRRIGATION.

Chapter X.

LAYING OUT OF THE LAND—METHOD OF PLANTING.

Generally speaking every farmer has his land under his eye and knows what to do with particular portions of the ground. He will plant wheat in this field, barley over yonder, further along he expects to have a patch of rye.

In the case of vegetables he follows the same practice and plants his cabbages, his beets, turnips, etc., wherever the fancy moves him. It is a haphazard manner of farming, and to it may be attributed failures which have been ascribed to the elements. From what has been heretofore said it must be apparent that there is something in soil and in the manner of planting which it would be well to heed; indeed, which must be heeded if success be desired and a crop assured. True, plants will grow if the seed be thrust in the ground; that is, after a fashion; and so will an animal grow if kept alive after a fashion, but the produce in both cases will be scrub.

The time is coming, if it has not already arrived, when farmers will be able to produce as much from half an acre of ground as from an acre, and better crops. Too much land is as great a bar to success as too little, for in the former case there is too much trusting to luck, whereas in utilizing nature for the purpose of wresting products from the bosom of the earth there is not the smallest element of luck; it is all pure science, knowledge, ability, etc. A man with the trifling commercial business keeps an account of stock, his books show just what he has on hand, his sales and purchases. His inventory shows where his varieties of goods are located on his shelves. But when it comes to a farm, which is never a small business, no books are kept, no account of stock taken, and the location of his crops are retained in his mind's eye. More than that, quality is little regarded, the varieties of soil are not considered, and plants requiring one kind of soil are fed on a kind they do not flourish in. This is the common rule.

Take any tract of land, large or small, and when the crop is growing there will always be spots where the plants are thin, sparse and sickly. Failure of proper cultivation? Not at all; nothing but failure to properly lay out the land so as to know what it is suitable for. The pollen of a sickly plant spreads as far as that of a good healthy one, and poor results are attributed to poor seed, etc., when a little care and forethought might have made the crop uniform and the results satisfactory.

This is preparatory to the subject of laying out the land, for upon doing that properly depends the success it is always desirable to attain in every species of farming for profit. If profit be not the desideratum, then why go to the trouble and labor of farming?

The proper laying out of the land is always of great importance, and where irrigation is practiced it is of the highest importance. Water runs down hill and it also soaks into the soil seeking the water table, and this water table is always receiving additions through the constant or periodical application of irrigation water, and rises to do damage.

Hence, drainage is to be considered as well as the slope of the land. The first thing to be done is to prepare an outline of the land, its boundaries. If a square tract the matter will be easy, for any sized square may be laid down upon paper and then measured off into acres or parts of acres to suit the convenience. A map of one's land is a necessity nowadays, and it is not difficult to prepare one. It is the farmer's diagram of the location of his stock, equivalent to the shelves in a store of merchandise. It tells him the location of his crops, the nature of the soil, his ditches and all their ramifications, and if anything goes wrong he can immediately put his finger on the point of trouble and go at once to correct it.

To prepare a map of the land measurements must be taken, and these measurements are expressed in tables universally adopted and can therefore always be relied upon as uniform. To begin with, an acre of land, whatever its shape, contains exactly 43,560 square feet, and after an outline has been traced upon paper, lines may be drawn from side to side and these lines crossed by other lines drawn from top to bottom. The map will then be covered with little squares which may be any part of an inch in size, but representing a given quantity of land; say one inch square on the paper represents an acre of ground; then if you have a farm of 100 acres your map will be ten inches square, if the land is a square, but whatever the shape of the land it will contain exactly 100 square inches. Not a very large map, but very convenient, for on it may be expressed the exact location of crops, even to a small cabbage patch, ditches, farm buildings, orchards, vines, etc., etc. Of course any scale to the acre may be selected instead of one inch. If the farm is large then make the scale one-half inch to the acre or even less, or if small make the scale two inches or more, to allow of the least details.

If it is desirable to make an accurate estimate of the amount of land in different fields under cultivation, the following table will be of assistance:

10x 16	rods	equals	1 A.	70x 69.5	yards	equals	1 A.
8x 20	rods	equals	1 A.	220x198	feet	equals	1 A.
5x 32	rods	equals	1 A.	440x 99	feet	equals	1 A.
4x 40	rods	equals	1 A.	110x369	feet	equals	1 A.
5x968	yards	equals	1 A.	60x726	feet	equals	1 A.
10x484	yards	equals	1 A.	120x363	feet	equals	1 A.
20x242	yards	equals	1 A.	240x181.5	feet	equals	1 A.
40x121	yards	equals	1 A.	200x108.9	feet	equals	1 A.
80x 60.5	yards	equals	1 A.	100x145.2	feet	equals	1 A.

100x108.9		feet	equals ¼	A.
25x100		feet	equals .0574	A.
25x110		feet	equals .0631	A.
25x120		feet	equals .0688	A.
25x125		feet	equals .0717	A.
25x150		feet	equals .109	A.
2178	sq.	feet	squals .05	A.
4356	sq.	feet	equals .10	A.
6534	sq.	feet	equals .15	A.
8712	sq.	feet	equals .20	A.
10890	sq.	feet	equals .25	A.
13068	sq.	feet	equals .30	A.
15246	sq.	feet	equals .35	A.
17424	sq.	feet	equals .40	A.
19603	sq.	feet	equals .45	A.
21780	sq.	feet	equals .50	A.
32670	sq.	feet	equals .75	A.
34848	sq.	feet	equals .80	A.

In measuring land there are three distinct operations to be performed: Taking the dimensions of the tract; delineating or laying down the same on a map, and calculating the area or superficial contents. All the tables applicable to land measurements will be

found in the Appendix, to which the reader is réferred.

For ordinary purposes a knotted cord or tape-line may be used. In measuring a simple figure, as a square field, nothing is necessary but to measure the length and the breadth, which, multiplied together, will give the superficial area. Where fields are irregular shaped, it is necessary to adopt some standard guiding form, and from that measure the different angles, so as to be able, from the dimensions taken, either to calculate the contents at once, or to lay down the form of the field on paper according to the scale adopted, and from that ascertain its dimensions and calculate its contents.

The simplest and most accurate mode of ascertaining the contents of all irregular figures is to throw them into triangles, and this method is usually employed whether a small piece of irregular shaped land is to be measured or a vast extent of territory. To find the contents of a triangle all that is necessary is to multiply half the perpendicular by the base. And this regardless of the shape of the triangle. In measuring land in this manner, and by a little calculation, every foot of land can easily be represented on paper.

TAKING THE LEVEL.

After the land is accurately measured, or measured satisfactorily to its owner, taking the level of its surface is the next thing in order, and in this there can not be too much care taken, particularly where irrigation is practiced. Upon it depends the proper flow of water in ditches, the flooding of land and adequate drainage.

To explain it will be necessary to be a little abstruse, but the idea will be readily grasped by thinking. The earth is a sphere, that is, "round," and all places on its surface, whether a ten-acre tract or one of ten thousand, are said to be "level" when they are equally distant from the center of the earth, and "out of level" when their distances from that center are not equal.

Now, because the earth is a sphere, or round, every level line drawn upon its surface from one point to another, must be a curve and part of the earth's circumference, assuming it to be perfectly smooth, or at least parallel with it.

The common methods of leveling are sufficient for irrigation on an ordinary tract of land, but for long canals and ditches miles in extent, the leveling must be in accordance with the curved level line to correspond with the surface of the earth equi-distant from its surface. The usual instrument for leveling is the road or mason's level with telescope and compass, the latter to get the bearings. For ditching purposes a "plumb-bob" level, a two-legged contrivance open like the letter A with a line fastened at the top and terminating in a pear, or "top" shaped piece of lead. In the exact center of the bar across the A is marked a notch, and when the point of the "bob" is at that center notch, the line is level. Illustrations of this and other contrivances for leveling land will be found elsewhere, and referred to in the synoptical index so as to be easily found.

To continue the level line a series of poles are necessary. These are so placed that the one nearest the eye conceals all the rest. To allow for inequalities of surface, a notch is cut in the starting pole, or at the point where the level line begins, and that point must be level with it all along the line. A small spirit level held to each pole, and the eye will demonstrate the exact level line for all practical purposes. This method is sufficient for small areas, to lay the level of a ditch, or its laterals, but in large tracts, of course, a surveyor should be called in. Every farmer with a hundred acres to level can easily do the whole surveying himself by following this apparently crude method, and be as accurate in his leveling as a professional surveyor.

Where there are curved lines to be drawn on irregular surfaces, a hill or a knoll, for instance, being in the way of a straight line, the mariner's compass may be brought into use to ascertain bearings, and a series of straight lines drawn which will make skeletons for the curves. In fact, it is no trick at all to draw a level line around a hill, or curve a ditch in the shape of a letter S or Z, by this simple method. All these measurements should be traced on the map, for even if not used immediately they will prove useful when necessary to ditch, or irrigate.

The following table showing various grades per mile will be useful as a basis of calculation in drawing the level lines for ditches or general irrigation purposes:

1 foot in	15 is	352	feet per mile
1 foot in	20 is	264	feet per mile
1 foot in	25 is	211	feet per mile
1 foot in	30 is	176	feet per mile
1 foot in	35 is	151	feet per mile
1 foot in	40 is	132	feet per mile
1 foot in	50 is	106	feet per mile
1 foot in	100 is	53	feet per mile
1 foot in	125 is	42	feet per mile

Any desired grade or "flow" can be calculated by remembering that there are 5,280 feet in a mile. By dividing 5,280 feet by the number of feet in length of the ditch, the grade or "fall" will be the result, estimating one foot as the desired fall or flow of the water in the ditch, and the desired fall or flow may be regulated when drawing the level line by notching the poles used in leveling.

ELEMENTARY INFORMATION.

To make this land leveling business clear to the mind of the elementary reader, let it be supposed that he desires to run a ditch from one point to another. He has the letter A-shaped plumb-bob leveler, half a dozen poles ten feet or so in length, and a carpenter's spirit level. With these he is prepared to run practically level lines all over a hundred-acre tract of land.

At the starting point ascertain the "plumb" point, that is, the spot over which hangs the lead bob exactly in the middle of the cross-bar of the A, then plant a pole, and at the height of the eye, say five feet, cut a plainly visible notch, or make any kind of a mark that can be seen from a distance. This is the standard of the entire ditch.

Next, take another pole, your A level, and the spirit level, and walk along the proposed line of ditch any convenient distance to a point. Four rods or so are not too far, less if there are obstructions to level around. Lay the A level over the selected point and ascertain the exact level of point two, as it may be called. Now place the spirit level against the pole about the height of the eye, and look along its top just as if "sighting" a gun. Slide it up and down, if necessary, until you find the notch in the first pole, with the "bubble" in the spirit level exactly in the center, and make a notch or mark in pole number two where the top of the spirit level touches it.

A calculation is easily made, for the notch on pole one is five feet from the surface of the ground, and by measuring the height from the ground of the notch in

pole number two, any variation will mean that another level point must be selected, or that there must be some grading or digging.

The second level point having been established, proceed with the third pole in the same manner, comparing it with the second pole, carefully noting the figures on paper, and so continue until the work is completed. Laterals may be run in the same manner, and the entire parcel of land gone over, the results in figures showing the slope or lay of the land for every purpose. This leveling, if carefully and completely done, will show numerous grades, or slopes in the same parcel or tract of land, and the knowledge of this is extremely valuable; in fact, necessary for irrigation purposes, whether ditching or flooding. It is often a very intricate matter to irrigate every portion of a given field uniformly, and failure to do so always results in lack of uniformity in any crop sought to be grown upon it, there being too much water on some parts and not enough on others. It will be understood that the waste of water and the loss in crop must exceed by far the expense of leveling the land in every direction. The chapter on irrigation will give details of flowing water on irregular surfaces, and reference to the synoptical index will point out comprehensive illustrations.

Before concluding this portion of the chapter on "Laying Out of Land," it is proper to add by way of information, that on July 28, 1866, the Congress of the United States legalized what is known as the "metric" or French system of measurements, and provided that "It shall be recognized in the construction of contracts * * * * as establishing in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures in common use."

That portion of the "French" system relating to land measurement is given here, in case any farmer should fancy it in preference to the "English" system, which has always been used:

	Pounds.	Pounds.	Pounds.
1 side of a square mile	320	640	900
1 rod in length........	1	2	3
100 rods in length.......	100	200	300
100 feet in length........	6 1/16	12 1/8	18 3/16

This metrical, or decimal, system is not in common, everyday use; on the contrary, it is rarely found except in Government reports.

The matter of fencing should not be omitted in this place, and so estimated quantities in the convenient barbed wire fencing are here given. The table gives an estimate of the number of pounds of barbed wire required to fence the space or distance mentioned, with one, two or three lines of wire, based upon each pound of wire measuring one rod (16½ feet):

METHODS OF PLANTING.

It must not be supposed that this part of the present chapter will exhaust the subject of methods of planting. The subject is too large and important to be treated in one place, and it is therefore distributed in other chapters to follow. But it is all important to consider the nature of the plant which it is purposed to grow, and plant the seed in such manner that it will have room to grow and develop its seed or fruit. If the previous chapters have been carefully read the reader will remember that great stress was laid upon the fact that all plants are great feeders, and that they are so by instinct, and to attempt to compel them to abstain from their proper food, or limit their food supply on the ground of economy or indifference, or upon the supposition that they will grow anyhow, is to reduce the product of that plant proportionately. It is always a losing plan to restrict the food of plants, for that means stunting their growth.

Now, whether the seed be sown broadcast, planted in drills, or the young plant transplanted, care must be taken that the roots have space to spread, or reach out for the required food. If they have not then they rob each other and fail to produce as desired. Plants are cannibalistic in their customs and must not be humored in the slightest degree.

There is a curious fact about the growth of plants which may not be out of place here, inasmuch as it will prove an addition to the reader's information concerning the peculiarities of the plant kingdom: Experiment has demonstrated that the smallest seeds, even, say the mustard or radish, sown in an absolutely sterile soil will produce plants in which all the organs are developed, but their weight after months does not amount to much more than that of the original seed. The plants remain delicate, and appear reduced or dwarfed in all dimensions. They may, however, grow, flower and even bear seed, which only requires a fertile soil to produce again a plant of natural size.

In planting without providing room for the plant to feed, or sowing, or planting too many of its fellows in too close proximity, the soil is rendered sterile by over-consumption, and the plants starve or fail to produce adequate crops. This well known fact, together with the application of the experiment above cited, will explain why, in rows of plants, there are spots where the plants do not grow to perfection so far as producing is concerned. They grow, it is true, but they are dwarfs.

There is another thing to be considered also in this connection, which is that plants are not all robust or healthy in the same degree. One may be so situated as to its environments as to be able to develop more quickly than its neighbors, in which case it will "crowd out" its neighbors, or absorb their food, which means the same thing. Just as when two humans sleep in the same bed, the healthy and vigorous one will absorb the vitality of the weaker one, a well attested circumstance in medical annals.

Experience has demonstrated beyond controversy that there is as much of a plant under ground as above it, whether that plant be a tree or a cabbage, and hence it is not difficult to gauge the proper distances in planting, if perfection of growth be the desideratum. Few, however, pay the slightest attention to this fact, and hesitate to "prick out" the superfluous plants in the radish or lettuce bed, and the consequence is they wonder why their neighbor grows such fine cabbages when they have the same soil and bestow the same care upon them. They do not give them the same care; the neighbor is economical, for he thins out his rows and gives the remaining plants room to grow. This means quality as well as perfection.

A Chinese gardener will grow vegetables so close together that they will touch, and anyone watching him will suppose that the thinning out process is not essential. But it is in his case as well as in all other cases, the only difference being, the Chinaman knowing very well that his plants will not grow if crowded together, and that they must be thinned out. But he knows the

reason, and that reason is that they must have food in sufficient quantities, so he gives it to them and makes up for lack of space by supplying food. This is why the Chinaman can be seen always dosing his plants with liquid fertilizers. He never rests, but is always at work "forcing" his vegetables to grow. Anyone can do the same, but the average American farmer, with his acres of land to the Celestial's square feet, does not deem it necessary to crowd his plants. Moreover, to speak truly, forced plants are never as substantial as those grown naturally, and this ought to be a sufficient reason for so planting that every individual plant may be surrounded by its own storehouse without encroaching upon the preserves of its neighbors.

The following table will assist the farmer in planting seed, bearing in mind always that the plant is as large under ground as above it, whether it be a tree or a cabbage. The distances are in feet, basing the calculation as 43,560 square feet to the acre:

Distances Apart.	No. of Plants.	Distances Apart.	No. of Plants.
1 x1	43,560	7x 8	888
1½x1½	19,360	8x 8	680
2 x 1	21,780	9x 9	537
2 x2	10,890	10x10	435
2½x2½	6,969	11x11	360
3 x1	14,520	12x12	302
3 x2	7,260	13x13	357
3 x3	4,840	14x14	222
3½x3½	3,555	15x15	193
4 x1	10,890	16x16	170
4 x2	5,445	17x17	150
4 x3	3,630	18x18	134
4 x4	2,722	19x19	120
4½x4½	2,151	20x20	108
5 x1	8,712	24x24	75
5 x2	4,356	25x25	69
5 x3	2,904	27x27	59
5 x4	2,178	30x30	48
5 x5	1,742	40x40	27
5½x5½	1,417	50x50	17
6 x6	1,210	60x60	12
6½x6½	1,031	66x66	10

To round out the above calculation, the following table of the quantity of seeds required in planting is added:

	Seeds, Per Oz.	Length of Drill, Per Oz.	Vitality, Years.
Asparagus	1,000 to 1,200	50 feet	4 to 6
Beet	1,200 to 1,500	100 feet	6 to 8
Carrot	20,000 to 24,000	200 feet	1 to 3
Cabbage	8,000 to 12,000	Transplant	4 to 6
Cauliflower	8,000 to 12,000	Transplant	4 to 6
Celery	50,000 to 60,000	Transplant	3 to 5
Egg plant	5,000 to 6,000	Transplant	5 to 6
Endive	20,000 to 24,000	Transplant	8 to 10
Lettuce	25,000 to 30,000	400 feet	5 to 6
Okra	500 to 600	50 feet	5 to 6
Onion	7,000 to 8,000	200 feet	1 to 2
Parsnip	5,000 to 6,000	200 feet	1 to 2
Radish	3,000 to 4,000	100 feet	4 to 5
Salsify	2,500 to 3,000	100 feet	4 to 5
Spinach	2,000 to 3,000	100 feet	4 to 5
Tomato	About 20,000	Transplant	4 to 5
Turnip	8,000 to 12,000	200 feet	6 to 7

The quantity of seed for the space specified in the second column of the latter table is much too great, but it is the conventional quantity and is given as the maximum. In our garden culture all of the common plants mentioned are susceptible to transplanting with good results, even the onion; but, of course, in field culture chopping out with a hoe is the most advisable method to pursue in thinning.

IRRIGATION IN JAMES RIVER VALLEY.

Farmers of that Section are Working out Many Plans for Good.

BY A. B. CRANE, M. S.
[Professor of Civil and Agricultural Engineering, South Dakota Agricultural College.]

(For The Irrigation Age.)

The James River Valley is a land of magnificent prospects. With a soil of great fertility, a genial climate, nearly enough moisture to mature all ordinary crops and an ideal topography, about the only questions which confront the farmer are: "How to supplement the natural rainfall" and "how to bring moisture to the crop at the time it is needed." These two questions are happily answered by the development of the artesian wells, an apparently unfailing source of supply directly at hand and only awaiting the invitation of the driller's tool to arise and do our bidding.

This district lies just at the edge of what is considered by irrigationists as the humid regions, its eastern limit being about twenty miles east of the James River and approximately parallel to it, following down between the 97th and 98th degrees of longitude. Its extent westward embraces the entire James River Valley and is limited only by the consideration of the relative values of stock raising as against agriculture, a consideration which changes with the increase of population and which has the effect of holding in reserve large tracts which later on become a source of supply for future occupancy.

Artesian irrigation in this region is not a mere theory; it is a fact, demonstrated by many instances and in many different localities. Farmers are conducting irrigation enterprises ranging from the home garden, the market garden and fruit patch to field irrigation of grain crops, and in nearly every case with marked success. The few failures can always be traced to, not the fault of the system, but the method—or, rather, lack of method. Many who have half tried it disparage the project, but those who have worked it the longest and most systematically speak in most glowing terms of its success.

The problems which confront the irrigationist here are slightly different in detail from those of the arid region, and upon the recognition of this fact and the proper solution of these problems depends the success of the operator. He must remember that irrigation in any locality is an experiment in which results depend upon the local conditions, the individual and the market. A set of cut-and-dried rules laid down for use in Colorado or Nevada may not be at all applicable here. One man with his methods may attain entirely different results from another with the same soil and water but different way of handling things, and he who observes, experiments and holds closest to nature's laws—in fact, applies common sense to his efforts—is the man who attains success.

To illustrate: The climate in the arid region is dry, the land lies in such a manner and the water has such a value that supersaturation is very rare. Here in this semi-humid climate we are apt to have several inches of rain at any time, possibly just after a good, thorough irrigation. Common sense would dictate, then, that some method of quickly removing a surplus of moisture is necessary; therefore a system of drainage

should be a part of every irrigation system in this district. Some farms will naturally drain, others can easily be made to do so; one that can not be drained should never be selected for irrigation. Yet, apparent as the necessity is, this idea of drainage is the least considered of any part of the subject.

Again, bulletins issued in the arid regions will state the supply of water needed during the growing season for a particular crop or that a certain amount of water is needed for a given number of acres. An irrigator will read these statemests and reason that the same amount is needed here. He forgets that a large amount of his supply will be furnished by the rainfall and that all he needs is enough to supplement any deficiency in this natural supply, thus making the duty of his irrigation reserve much higher than in the region for which the bulletins were compiled. He should have a rain gauge on his farm, and if he is where he can get the benefit of the Signal Service reports so much the better. "Seek to supplement nature, not to outdo her. Observe and experiment for your own locality and follow what is thus shown to be the best policy," should be the motto of every irrigator.

The water from these wells is quite warm, ranging from about 60 to 90 degrees, a temperature very favorable for plant growth. On the other hand, however, it lacks organic matter which aids materially in plant nutrition. This can be partially supplied, though, by storing in reservoirs for awhile before hunning it to the fields.

The question often arises, "How much land can be irrigated with, say, a two-inch well with an ordinary flow for such size wells?" Those who have had the most experience say that with proper storage facilities and judicious rotation a quarter-section or even more can be easily handled.

It might be well now to consider some of the methods which experience has proved to be particularly applicable to this artesian basin. The following methods were given to the writer by those who had experience with them and gave them as their conclusions:

For small grain, plow in the fall, then irrigate by flooding thoroughly, but not enough to leave water standing upon the surface, and shut off the water before the ground freezes up for the winter. This puts the ground in good condition for the seed in the spring and usually no more moisture is required. If the year is extra dry, a medium wetting just before the grain begins to head is beneficial. For corn, usually no irrigation is required till after it is "laid by," then a furrow is directed down every row or every other, depending upon the topography of the surface. The ground is so well shaded by the foliage that it does not bake or pack.

For gardens have the soil properly moist in the spring to insure quick germination of the seed, then water when it appears to need it, but remember that cultivation is a necessary adjunct.

For small fruits a good wetting just about the time the fruit begins to set is all that is necessary.

The results of the efforts of those who have systematically conducted their work is very flattering. After a well is once dug (and they are a paying proposition though used merely for stock and domestic purposes), the expense of ditching and applying the water is merely nominal, being practically but the labor involved. The results are:

About double the ordinary yield of small grain and a three or fourfold increase in garden crops and fruits.

A practical surety of a full crop every year.

A great improvement in the quality of the grain. Several men report that they have never raised anything but No. 1 grain since they began to irrigate.

Market gardeners report a yield of from $100 to $150 per acre from their produce.

It would seem that with all these advantages and opportunities before them more men would engage in irrigation, yet the number is comparatively small. As stated at the beginning, this is a country of magnificent prospects. These men are the pioneers who blaze the way and show what can be done. Others will soon learn from them and follow their example. There is no reason why the James River Valley should not develop into one of the richest agricultural regions in the

SCENE IN THE BEAUTIFUL PAYETTE VALLEY, IDAHO.

HYDRO-ECONOMIC STUDIES.

A forthcoming report of the United States Geological Survey will contain valuable data concerning the use of water in the manufacture of paper. It will also contain the results of an inquiry into the manufacture of soap. Especial attention is now directed to procuring similar data concerning the manufacture of woolen and cotton textiles. An inquiry is being prosecuted to determine the damage done to water supply interests by stream pollution, and a compilation of antipollution laws is in progress. Arrangements are being made for chemical surveys of the waters in Florida, parts of Georgia and Alabama, West Virginia, southern Ohio, Pennsylvania, South Dakota, Iowa and Kansas and the irrigation waters of the reclamation States.

CALIFORNIA.

A California venture provides for what is termed the most extensive irrigation canal project in the state of California, contracts having been let for the completion of a canal which will extend from the northern boundary of Glenn county to the southern border of Colusa, watering one of the richest sections of the state, through a distance of eighty-five miles.

The Butte County Canal Company, in the same state, will divert the waters of the Feather river to cover 180,000 acres in Butte county in the neighborhood of Oroville, Biggs, Gridley and Liveoak. Articles of incorporation for the company have been filed and plans look toward a fifteen-mile main canal, with 6-foot bottom and a combined length of nearly 200 miles in main and lateral ditches. It is promised that the rate per acre for water will be the lowest in the state.

IRRIGATION BY PUMPING, RIO GRANDE VALLEY, TEXAS.

BY E. STONEY PORCHER, EL PASO, TEXAS.

As you have so recently been to El Paso and taken a trip down the Rio Grande valley, suppose you would like to have some particulars of our situation as to water facilities. This valley used to have all the water needed on both sides, tradition says for two hundred years, but for several reasons, among the most potent, the water is being taken out each year more and more above us, so that now we have lost faith in our ability to depend on it, unless the United States government will agree to join Mexico and put up what is called the International dam. This I suppose you are posted on. We have been experimenting for the last four years with our underflow, and we now have twenty-three small pumping plants below the city of El Paso, 5-, 10-, 28-horsepower engines. While we have an unfailing supply of water, we have but a shallow gravel bed ten to fifteen feet thick and sixty feet down. The water rises to within ten, twelve and fourteen feet of the surface. We can get economically 600 to 800 gallons per minute from a 6-inch pipe with a twelve foot slotted strainer, which is the only kind we have gotten any satisfaction from. The slots are 3-10 to ¼ inches wide, the steel being perforated as full as the metal can stand. This lets in all the sand and keeps out the gravel, thus giving almost, if not quite, as good results as an open well and at one tenth the cost.

One drawback has been the high price of gasoline. Eighteen cents per gallon is too much to pay for irrigating alfalfa or ordinary farm crops, but we have in sight several crude oil converters that will convert crude oil into gas. The gas engine is the only economical engine to use in this arid region. To show what can be done with a small 5-horsepower Columbus gas engine, I will give you an experiment I have just finished making on a four acre lot of alfalfa that you saw in front of my dwelling. It contains about four acres of alfalfa. The field the longest way is 550 long, divided in narrow tables by borders about thirty-six feet wide. Two of the tables are wider, one sixty-three feet. I have a gasoline can that holds just one inch of gasoline for each hours' run. In this test I measured the gasoline every hour to see that the engine was drawing on it uniformly. Then I placed a stake on the borders for marking how far the water had got each hour. I afterward measured by a tape line their length. This was some surprise for me. First I measured the water pumped over a wier two feet wide placed according to regulation. This gave me 240 gallon average. The four acres should have taken 360,000 gallons of water to cover it three inches deep, but I actually pumped 700,000 gallons, nearly double the required estimate. Again having a small flow I supposed the narrow table would be covered more economically, but it was not so always for the average cost for the four acres was $1.03 of gasoline per acre, and this sixty-three foot table cost at the rate of eighty cents per acre. This difference can be accounted for only by the supposition that the land sloped faster and was less porous. The longer the table the more it costs, as you would expect. So with a small flow of water the table should be made short and narrow and cross ditches placed in. For instance, on one table the first two hours' run covered 310 feet in length of table, and the next two hours 245 feet of table, the width being the same. At our lower place my son estimated that it cost seventy cents per acre on his alfalfa on a field freshly plowed and sowed with alfalfa seed, and three-quarters of a mile from pump it cost $1.25 per acre. This place has a 10-horsepower engine, and No. 6 Johnson rotary pump.

All that we lack now is cheaper fuel, and I believe we will get this before the next pumping season, as I know of five machines that are, or will soon be, on the market for converting crude oil into gas for our engines. Some promise as great a difference as fifty cents to $4.00 cost for a day's run, the first being crude oil, the last gasoline. If the gasoline was cheaper it would be unsatisfactory, as the supply here is constantly running out. We did not know what this land could do until we got pumps. Any farmer knows that when our crops need water they must have it for a maximum yield. That part growing over the canal is not always available as we have to take our turn, as in this very dry climate when plants are set out in summer, if irrigated at the time they will need water again in two or three days. Our evaporation, as given by the hydraulic engineer of the army, was eighty inches during the year. The Arizona Experiment Station gives the amount of water necessary for alfalfa as seventy-two inches.

What would be an ideal thing for this valley would be the sending of an electric wire through its length to supply power for the number of pumps required, provided they will furnish power cheap enough. That they could do so seems certain, if they use a recent invention made by a California firm. To quote the words of the president of an electric road: "The service has been satisfactory, that they have never had a shut down, and that the cost for crude oil at $1.13 per barrel has been within 3-10 cent and 4-10 cent per kilowatt power." We are far behind England and Germany in the use of gas engines. One concern using the Mond retort for making producer gas for power has got a charter from parliament, and they are putting up a plant that will deliver gas at four to six cents per thousand feet, twenty-seven miles in all directions. The gas is made from the tailings at coal mines. They can do this, for a part of Professor Mond's invention is to save the nitrogen to such an extent that they could pay over $2.00 per ton for the coal, and the nitrogen or ammonia will more than amount to this for each ton used. You will find a full account of this in the August 15, 1903, No. 23,086 of *Scientific American Supplement.*

We have all kinds of soil in this valley, and being in the midst of a desert, a part grown city El Paso, a mining and railroad center, we have a good market, do not begin to supply it. A great deal of produce that can be bought here is brought from California. This will always be so to a certain extent in winter and spring fruits and vegetables.

We have a beautiful climate, cold at night in winter, but few very cold days although we are 3,700 feet up.

Some vast areas of land in the Milk River Valley, Montana, have been withdrawn from entry and United States surveyors are surveying it preliminary to starting irrigation work to reclaim it. No settler can get an acre of this land without living upon it for five years, but there is nothing to prevent the land grabbing combinations from plastering their scrip all over it.

QUESTIONS FOR IRRIGATION ENGINEERS.

How Men Are Tested as to Their Qualifications For Work in Colorado.

Mr. L. G. Carpenter, State Engineer of Colorado, sends The Irrigation Age the following copy of the probe for the examination of division engineers, including questions asked at the second examination in Division No. 1. They are especially interesting as showing the general scope of the examination and the attempt which this includes to get at the qualifications of men whose duty it will be to distribute water:

MEASUREMENT OF WATER.

What is a cubic foot per second?

What is the statutory inch? What is its value in cubic feet per second?

The gate of a headgate is 4 feet wide and is raised 6 inches from the floor; the water stands 4 feet deep on the floor in front of the gate, what is the amount of water discharged through the gate? Give the full computation.

Describe how a weir should be placed and under what conditions and how the depth should be measured in order that the weir be reliable?

Describe (1) where the rating flume of a ditch should be placed; (2) under what conditions; (3) why and (4) what conditions to avoid? Why?

How would you proceed to rate a ditch or canal? Give the process in full.

A weir is 3 feet long; the water is 6 inches deep; compute the amount of water being discharged?

A ditch takes out water in openings 9 inches deep without pressure; the opening 10 inches wide is then called 90 (ditch) inches, how much water is discharged from such an opening 10 inches long? Are these inches greater or less than statutory?

How much will a valve 40 inches in diameter discharge if the head is 40 feet on the center of the valve?

If the depth over a wide-crested dam is 8 inches and 100 feet long how much is the discharge?

FIELD MEASUREMENTS OF WATER.

Question 1.—Each candidate will be expected to estimate the flow of water in two ditches: (a) By eye; (b) by float or other approximate means, without instrument; (c) by current motor.

Method.—Make estimate (a) in writing, sign your name and hand to the examiner, before (b). Likewise, complete (b) and hand slips with your results to the examiner. Give the method in full with the calculations; (c) make measurement in full as you would in measuring a ditch. Give full calculations.

Question 2.—Make the rating of a ditch, giving the process in full and making the rating curve and rating table.

What is the basis for water rights in Colorado? Does this apply to irrigation exclusively?

What is the guide for the commissioner or engineer to follow in the distribution of water?

If the stream is fluctuating, due to storms, snow melting, etc., and the earlier priorities are down the stream, how will you meet the practical problem of recognizing priorities and still utilize all the water? Suppose a rise of water occur in the river, how will you proceed?

What are the powers and duties of a division irrigation engineer? What authority does he have over water which is not given to the commissioner?

To what extent may a commissioner interfere with the distribution of water from a ditch? What is the legal basis for your statement?

A person owns two shares in a ditch and also owns an interest in a certain reservoir. One share, Share A, is used to irrigate a certain farm. Share B is unattached. The court has specifically decided that Share B can not be used for storage in the reservoir but has never passed on Share A. The owner claims this holds only because of failure to appeal. He proposes to irrigate the farm with Share B, setting free Share A, and to store Share A. What is your decision and why?

A ditch had an early appropriation for 60 cubic feet per second. It habitually runs a large amount to the lower end and wastes back into the river; the ditch claims it can because of its decree, others claim that it is calling for water unnecessarily and should be refused the water which runs back into the river. Which is right and why?

Suppose an early right is some distance down a sandy stream; likewise, suppose that because of the absorption of the sand no water reaches the lower ditches. The lower ones claim that the water should be turned down, that even if it fails to reach them it serves to fill the sand and when a rise comes it will be more apt to reach them. On the other hand, those above claim that this is waste and that the water should be turned where it does the most good. What is your decision and why?

Two ditches, which we may call A and B, had headgates near each other, A being above B, they united in building a headgate, part of the gate being known as A's and part B's. There was a stretch of canal owned in common and then at the end of the stretch each had his own gate. The priority of B is earlier than that of A. A has bought some shares in B. The water represented by these shares, however, transferred to A. Now they claim the water for B should be measured in the common stretch of canal, and that, when they desire it they will run it into A or B. What is your decision in the case and why?

LOCAL CONDITIONS.

Give the limits of this division; the numbers of the water districts constituting it and their location by streams?

Describe three districts of the division, their problems of administration and the questions they are apt to send up to the division engineer?

Where is water storage used? What problem does it introduce into the administration and why?

Suppose a ditch on the Platte river has stored water in a reservoir on say Boulder Creek; how is that water to be delivered to the ditch below?

Forest preservation and home building are hobbies—specialties of President Roosevelt. In his speech at Grand Canyon, Ariz., he delivered this sound advice: "Whether it is the forests, the water, the scenery, whatever it is, handle it so that your children's children will get the benefit. We have gone past the stage when we are to be pardoned if we simply treat any part of our country as something to be skinned for two or three years for the use of the present generation. Apply irrigation under circumstances that will make it of benefit, not to the speculator who hopes to get profit out of it for two or three years, but so that it will be of use to the home makers—to the man who comes to live and have his children stay after him."

RECLAMATION IN CALIFORNIA.

Negotiations Between the Government and the Owners of Cache Creek Rights Have Failed.

SACRAMENTO, CAL., February 10th.

Within the past year water rights of Cache Creek have been concentrated under one holding by certain parties living in Woodland, their intention being to develop Clear Lake as a reservoir site for the irrigation of the lands of Yolo County. It was the understanding that the object was the general development of the county.

"The agents of the Geological Survey have held numerous conferences with these gentlemen with a view to having this work undertaken under the Reclamation Service. The Survey was inclined to make favorable recommendations to the Secretary of the Interior bearing on this subject, provided a favorable adjustment of water right questions could be arrived at with these owners. After negotiations had been carried on for several months, assisted by the Governor of the State, it was found impossible to reach a conclusion with these gentlemen that could be recommended by the engineers of the Government to the Secretary of the Interior. It was a matter of regret that this adjustment could not be accomplished, as it is believed natural opportunities of marked merit exist here, and the broadest development of these lands and prosperity of the community would be accomplished in this manner.

"The entire project hinges on the use of Clear Lake as a storage reservoir. This body of water, covering 40,000 acres, has been declared as navigable by several acts of the California Legislature, and it is a serious question whether it can be used legally without the consent of the Government. It was not deemed advisable to legally contest this point at present. The California Water and Forest Association, as well as the Woodland Chamber of Commerce, co-operated with the Geological Survey in the investigations of Cache Creek. The Government is maintaining physical records of streams and lake.

STONY CREEK.

"Stony Creek is a western tributary of the Sacramento. In co-operation with the California Water and Forest Association, as well as with the Willows Chamber of Commerce, the Stony Creek basin was investigated by the Geological Survey; numerous reservoir sites were found thereon, and gaging stations established, the records on which are still being continued. A report on this drainage basin has recently been issued by the Geological Survey and is known as 'The Storage of Water on Stony Creek, California,' by Bert Cole.

"Puta Creek, another tributary of the Sacramento, has been explored during the past season; a reservoir site found thereon, and a gaging station established.

UPPER SACRAMENTO.

"A general reconnoisance has been made of the upper basin of this river, and a number of reservoir sites of marked value have been found, notably at a point near Red Bluff and at Biebor. These great reservoir sites could be used in connection with the general program mentioned above for supplementing the available late summer water for irrigation in the Sacramento Valley. Other sites have been found, particularly on the south fork of Pitt River. Gaging stations have been established at all of these sites to determine their available water supply, and during the coming season detailed surveys will be made of them. In all there are being maintained records of flow at ten gaging stations in the valley of the Sacramento River, and the entire time of an engineer has been assigned to the maintenance of these records. These will be continued until a complete report is made outlining the general possibility of developing this great valley in a comprehensive way and so as not to interfere with navigation.

"It will be desirable in connection with this general study to investigate the overflow problem of the low valley lands and consider the subject as a comprehensive whole. There is a very small area of public land available for irrigation apparently in the drainage basin of this stream, and the general development of this situation will be dependent upon the organization and co-operation of a great number of individuals who are now landowners in this district. It is a matter worthy of note that both the National Irrigation Association and the Trans-Mississippi Congress during the past season have passed general resolutions favoring the construction of great public irrigation works on the Sacramento River. The undertaking will be a vast one, and the province of the Geological Survey is to make a complete report to the Secretary of the Interior as well as the Governor of California outlining the latent possibilities.

"Probably no section of arid America has greater natural resources or has left them in a more undeveloped condition than the Sacramento Valley. Favored by geographical location, climatic conditions, soil and water supply, this valley should be one of the densely populated districts of the United States, rivaling in wealth and prosperity the famous valley of the Po in northern Italy, which it so closely resembles.

OWENS VALLEY.

"Owens Valley is situated in a district that is sometimes called 'undiscovered California.' It lies on the eastern side of the Sierra Nevadas in Inyo County and is flanked by the most rugged and picturesque range of mountains on the continent, blessed with a copious water supply, but isolated because of imperfect transportation facilities. Mr. J. C. Clausen is the engineer assigned to the study of this district. Probably a material area of arid public land may be reclaimed here. All the remaining public lands in this locality have been withdrawn subject to entry only under the Reclamation Act.

"An extensive reservoir site has been found on the main river above Bishop, and this has been surveyed in detail during the past season. The irrigable lands are now being mapped and classified. The whole situation is dependent on the factor of the remaining available water supply. In order to determine this the capacity of reservoirs must be found, the flow of the streams determined and the present diversions of canals closely gaged. Mr. Ralph S. Hawley is devoting his entire time to these water measurements, and is maintaining eighteen gaging stations in the Owens Valley district. The people of this community are extremely anxious to have the Government store the surplus flood waters and regulate the stream flow, not only for the benefit of their lands, the supply of which is now somewhat irregular, but also for the extending of the irrigated areas. It is probable that a drainage system in connection with the general development will have to be constructed, as large areas of land in this valley have now been ruined by the excessive use of water, and

it is believed that the available supply can be materially increased by their adequate drainage.

"From discussions with railroad officials and the people of the valley the conclusion is believed to be fair that with a general development of the valley by the Federal Government, transportation facilities will be greatly improved and railroad connections established with the South, which is the natural outlet of the valley connecting with southern California points. The work in the mountainous portion of the district has been discontinued owing to the winter season, but will be renewed in the early summer.

KINGS RIVER.

"The U. S. Geological Survey has made extensive investigations of the drainage basin of Kings River and the lands irrigated therefrom. A report has been published under the title 'Storage of Water on Kings River, by S. B. Lippincott.' This report points out the possibilities of utilizing certain reservoir sites of large capacity on this stream for the regulation of the water supply and the extension of irrigated areas.

"At the time this report was made all the canals on Kings River associated themselves in an organization known as the Kings River Storage Association. The platform on which they stood was to the effect that they had been spending about $40,000 a year in lawsuits over these waters, and they considered it more desirable to construct works to increase the water supply than to litigate over the natural flow. The great result which this Association accomplished was to reach an amicable agreement among themselves for the proper division of this water. Schedules have been arranged which determine the division of waters under all varying volumes for the different periods of the year. Litigation has practically ceased and good will prevails. Probably fifty lawsuits have been dismissed as a result of these agreements. This Association combined with the Geological Survey for the examination of this district. At the request of the president of the Association the engineers of the Reclamation Service went to Fresno and, at an extended meeting with them, explained the operations of the Reclamation Service with a view of constructing these reservoirs as public works. The matter was extensively gone into at two conferences held at Fresno in November.

"The flow of Kings River is peculiarly adapted to the needs of this district, or inversely such crops and agriculture has been developed in this locality as best suits the flow of the stream. In other words the vineyards, if supplied with a copious volume of water in the spring and summer when the river is normally at its flood flow, are able to produce satisfactory crops without the mid and late summer irrigations. However, the dairy industry, which is now beginning to be developed in this region, requires a continuous water supply. The operations of the reclamation law were fully explained to the officers of the Kings River Storage Association, representing some twelve or fourteen canal companies, and it remains largely with them to say whether the construction of these reservoirs under the federal law shall be undertaken. The sentiment expressed at the meeting was rather unfavorable to the procedure because of the expense involved, and because of the general satisfaction with present conditions.

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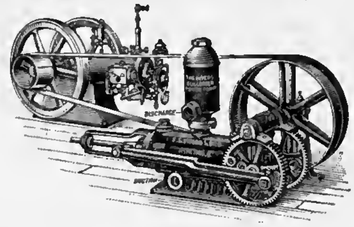

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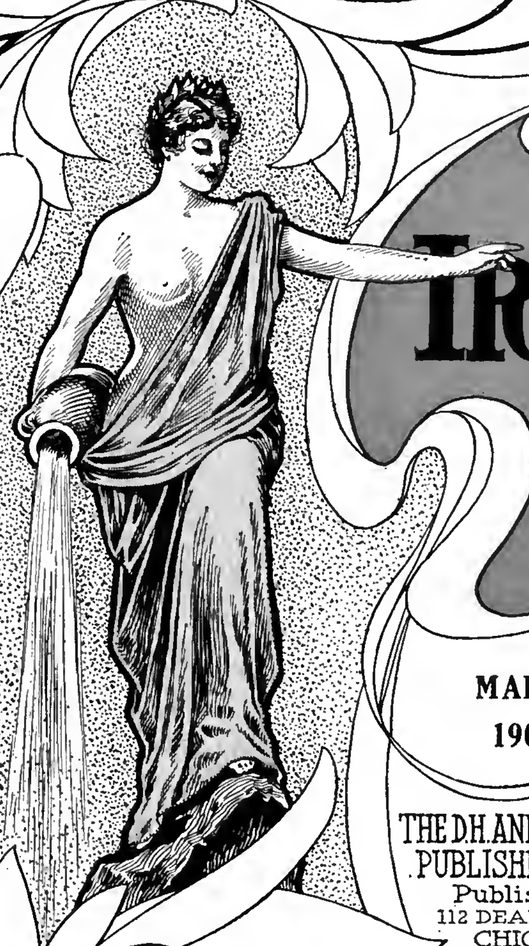

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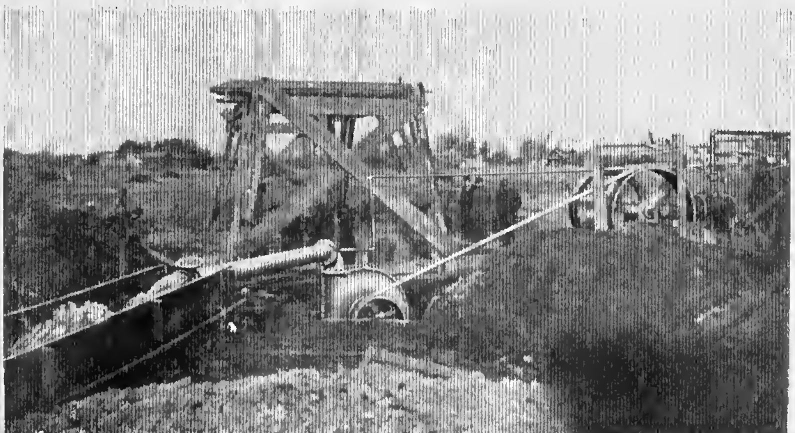


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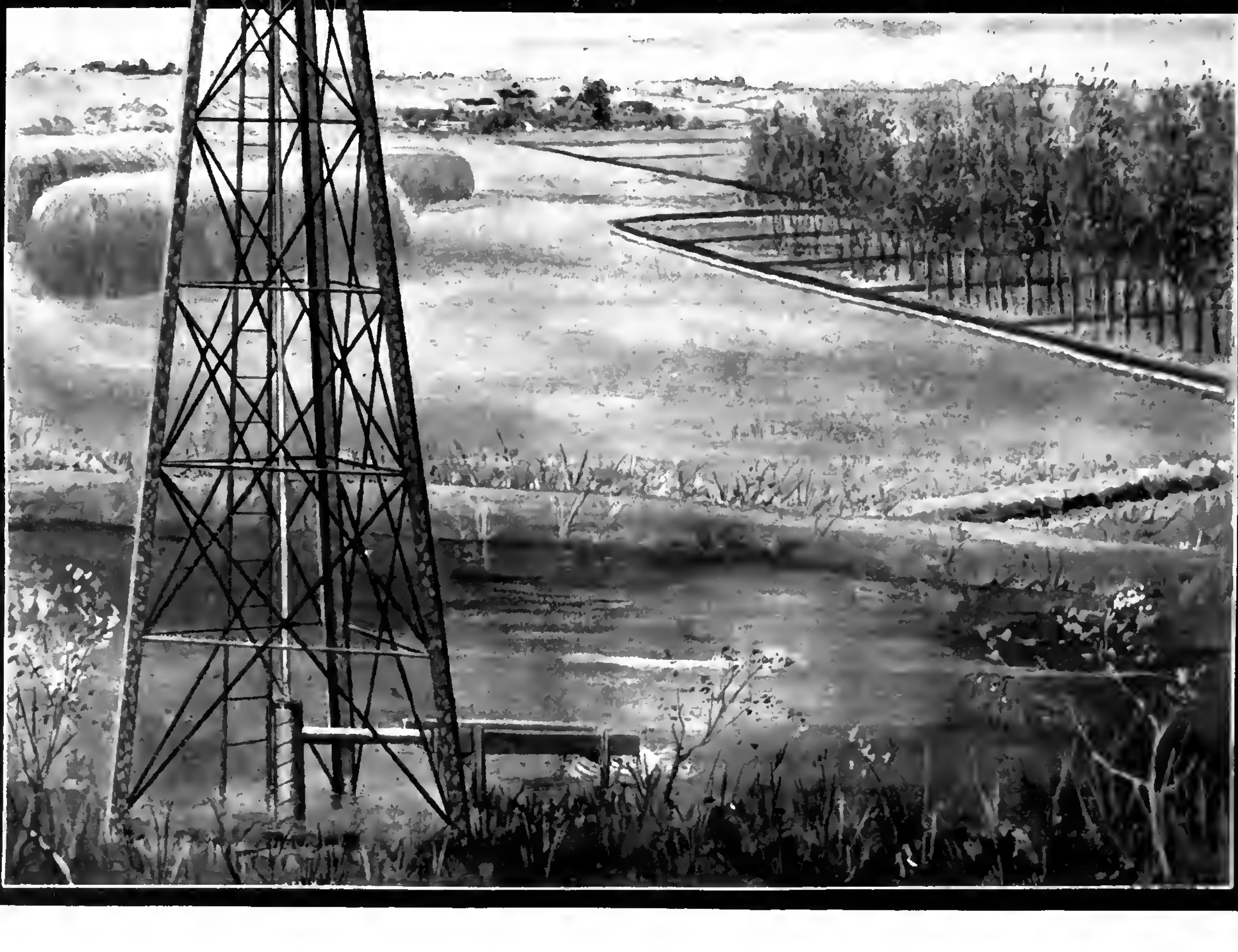

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EDITORIAL

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Nevada at St. Louis. Nevada will have a great exhibit at the World's Fair. In the Miners' Palace there will be 118 varieties of ore shown and the mines from which it was taken, its value, etc., will be given. One of the features of this display will be the Yerington nugget, a 271-pound lump of ruby silver that was taken from the mine of Tonopah. Irrigation in Nevada will be brought to the attention of the visitors through models of the Wadsworth Canal, which has been built at a cost of $1,000,000. Nevada's enterprise in this matter is highly praiseworthy, and other arid states will no doubt make equally valuable and interesting exhibits.

No Danger of Shortage. The land-grabbing Octopus is spreading the most alarming reports concerning the rapid absorption of the public domain, declaring that it will only be a few years until the poor homeseeker will be unable to find a vacant spot big enough for a garden patch. The cry of the Octopus is that it is working entirely in the interest of the future generations, and for that reason demands that all public lands be withdrawn from entry, except as it may be taken up under the general homestead law.

To show the fallacy of this position and that the Octopus is trying to create a false alarm, it may be stated that Uncle Sam still owns, exclusive of Alaska, over 500,000,000 acres open to settlement. This does not include about 60,000,000 acres in forest reserves and 60,000,000 acres in Indian reservations outside of Indian Territory.

The territory still unoccupied and subject to settlement is over five-eighths as large as the entire acreage disposed of under all laws since the foundation of the Government. This is equal in area to the thirteen original States of the Union, and in addition Iowa, Illinois, Wisconsin, Michigan, Arkansas, Alabama, Missouri, Mississippi, Indiana, Louisiana, Ohio, West Virginia, Tennessee and Kentucky.

Allowing for the depredations of timber thieves and others, there will be plenty left.

Elwood Mead's Good Work. There is a branch of the department of agriculture that is doing a good work for the coming farmer of this country, but which has attracted but little public attention. This is the division of irrigation and drainage investigations and is in charge of Prof. Elwood Mead. This division is in the department of the Office of Experiment Stations and Professor Mead's work is in direct connection with the Experiment Stations of the various States.

Professor Mead is now making an extended trip through the Western States for the purpose of planning the work of his department for the coming year. He has been in close communication with the Iowa Station, which has had charge of the drainage work of that State, and has followed the work there very closely. His department has given the State much valuable aid in the actual work of drainage that has already been done. Professor Mead also spent several days in Western Kansas, where the Government is doing considerable irrigation work, and from there he went to Colorado and inspected the various plans for irrigation that the Government is now carrying out. He is now in California, where he will spend some time in connection with the work that has already been undertaken there by the Government through the State Experimental Station. His entire trip will occupy some three or four months and during that time several experimental plants for irrigation by pumping will be established. One of these will be in New Mexico, another in California and a third in Arkansas.

The Arkansas experiment will be one of great value to the farmers of that State. Lying to the eastward of Little Rock there are large areas of land that has never been cultivated because they have not been properly drained. The soil, while rich in some elements, does not possess all of the elements necessary to the production of ordinary field crops. Professor Mead believes that this land will make good rice land and he will establish a pumping station under the direction of a competent drainage engineer who will lay out several plots and plant them to rice. Farmers in that section will be invited to visit the station and investigate the work as it progresses.

From some investigation, on a small scale, carried on last year, enough has been learned to warrant the belief that this land will produce large yields of good rice. If this belief is well founded, the State of Arkansas will have another very valuable product added to its agriculture and Professor Mead's department should have full credit for the work.

Rice culture in Texas, which has become so important a factor in the production of this country, is due very largely to the intelligent investigation and experiments made by the department of agriculture. Professor Mead is a man of plain practical sense, and all of his experiments are conducted solely with the view of teaching the average farmer how to do things properly. He applies science in the simplest way possible and is always careful to make his applications practical and easily understood.

Then and Now. When the present irrigation bill was before Congress the land-grabbing Octopus, which is composed of the most powerful interests in this country, opposed it bitterly. They sent their hired agents all over the West to proclaim that there should be no general bill, but that special bills should be passed from time to time for the building of specific works. They denounced everybody who in any way favored the passage of the act and the files of many western newspapers, whose editors were misled by their representations, show that they fought it as vigorously as though it meant the confiscation of every railroad in the West and the financial destruction of every bloated scrip owner in the country.

A strong committee representing the Octopus even went so far as to try to raise a doubt in the mind of the President as to the merits of the bill and impress upon him that it was a dangerous and totally unwise measure. They sought a conference with Mr. Roosevelt without notifying the supporters of the bill in the hope that they might so prejudice him against it as to enlist his influence in opposition; but the friends of the bill, including the members of Congress who favored it, were called to a later conference with the President and they, upon their own motion, invited representatives of the Octopus to be present. The President listened patiently to the discussion at this conference, and with his quick grasp of the truth, immediately saw that the objections which had been raised were merely captious and of no real importance.

No changes of importance were made in the bill after that conference and it passed practically in the form as it came from the original unofficial committee of seventeen which contained a representative or senator from each one of the arid land States and territories. In spite of this fact, however, the representatives of the land-grabbing Octopus sent broadcast the assertion that they had forced vital amendments to it, and seeing that the bill would be passed in spite of their opposition and that they were unable to emasculate it in any way, promptly claimed all the credit for it, and ever since that time have championed it as the fulfilment of their own fondest dreams.

The object of this sudden conversion is plain. It is to create the false impression that the Octopus is and always has been the honest advocate of the law in order to strengthen its attack upon the land laws. The money to carry out the provisions of the irrigation law comes from the sale of public lands, and the repeal of the commutation clause of the homestead act

and stone and timber act would practically amount to a repeal of the irrigation law. For, without the money derived from this source, the irrigation plans of the Government could not be carried out, and the Octopus would be able to accomplish the very object it had in view when it fought the passage of the national irrigation act with such fierceness and determination.

The true friends of irrigation and the small home-maker should not be deceived by the arguments presented by the land-grabbing Octopus but should adhere steadily to the determination to retain upon the statute books the present land laws with such amendments as may properly safeguard them from the raids of unscrupulous and thieving land combinations.

Acquirement of Water Rights. The office of Experiment Stations of the United States Department of Agriculture just issued a bulletin on the Acquirement of Water Rights in the Arkansas Valley in Colorado, by Hon. J. S. Greene, of Pueblo, formerly State engineer of Colorado, prepared under the direction of Elwood Mead, chief of irrigation investigations. The bulletin is written especially for those who are contemplating settling in the Arkansas Valley, and is intended to give them such an understanding of water rights and the conditions which affect their value, that they can act intelligently in acquiring a water supply. Mr. Greene has been for many years a prominent irrigation engineer of Colorado, has administered the laws of the State as the State Engineer, and is a landowner and irrigator under some of the canals dealt with in the bulletin. He has, therefore, had to deal with the questions discussed from the standpoints of the investor, the public, and the individual farmer.

Water rights are acquired from the State, in the first instance, but the individual settler must usually secure a right from some individual or company which has built a canal for the purpose of supplying water to farmers. The value of both classes of rights depends very largely upon physical conditions and upon other rights to the streams. Mr. Greene shows this connection and points out the sources of information as to these conditions. Rights purchased from canal owners are subject also to the conditions of the contracts under which the water is supplied. A large number of these contracts are given and discussed in such a way that an intending settler can tell what points he should look into before purchasing a right.

The laws and contracts are discussed also from the standpoints of the canal owner and of the public welfare. The report is therefore of great value to students of irrigation law and economics since it gives much valuable information and its interpretation by one who has studied it from every point of view.

The conditions in the Arkansas Valley in Colorado do not differ essentially from those in other parts of the arid West, and the report is therefore of interest to any one wishing to understand the subject of water rights in the United States.

Value of Pumping. The importance of irrigating land by pumping water from the underflow is beginning to be recognized, and this feature of irrigation is growing very rapidly. The national irrigation act has stimulated this work enormously and has already increased the demand for the irrigated lands of the West. Experiments show that in many portions of the arid West wells sunk from eighteen to fifty feet will supply large sections of land which can not be irrigated in any other way, and in this manner low or seepage land can be made valuable by water being forced up onto the dry and unprofitable tableland. No storage reservoirs are necessary and the expense of canals and irrigation ditches is thereby saved. Tests have recently been made at a distance of seventy-five to one hundred miles distant from the foothills, in which it was found that water could be had in abundance along draws and dry waterways at four to eight feet below the surface. It is believed that the underground flow will constantly increase and that this source of water will be unfailing.

Not a Work of Art. The report of the Irrigation Congress at Ogden is out, but it will never occupy a high place in literature or mechanical art. This report, it is naturally supposed, would have been prepared by Hon. H. B. Maxson, secretary of the Congress, but it is only after a diligent search that his name was found in small type hidden away in a mass of other names. The cover page announces that the report was "edited by Gilbert McClurg," and again the proclamation is made on the title page that this work is "Officially Compiled and Edited by Gilbert McClurg, of Colorado Springs, Colo., General Representative of the Executive Committee and Director of Promotion, Publicity and Program of the Eleventh National Irrigation Congress."

A full-page half-tone picture of Mr. McClurg, who is commonly referred to as Hon. Fred J. Kiesel's "one thousand dollar beauty," is one of the most striking objects that adorns the front pages and Mr. McClurg is very much in evidence all through the book. Mr. McClurg and his side partner, Mr. Willis T. Beardsley, have taken five months for the preparation of this report, the time being mainly spent in importuning members of the Congress for permission to print their portraits at so much per and for contributions.

This has been a gigantic begging game from the start and in no manner reflects credit upon the Congress. Cheap paper, cheap cuts, and cheap printing are the characteristic features of the report. Extra copies are sold by McClurg & Beardsley at one dollar each.

Desecration of the Cross. The land-grabbing Octopus in its desperation over the probable defeat of its effort to repeal the land laws, has desecrated the Christian Cross by announcing that it will continue its unholy fight under its protection. The organ of the Octopus in its last number prints a large picture of the Cross on its cover, flaunts it in the face of its enemies and announces its intention of following this holy emblem in its unholy crusade against the rights and liberty of the American homeseeker. Think of it! The various interests that compose the land-grabbing Octopus raising aloft the Cross of Christ, and with sardonic hypocrisy announcing that it has enlisted under this emblem as though its cause were a righteous one and entitled to the protection of the Deity. This is the limit of frenzied desperation and points to the conviction that the Octopus realizes that defeat is inevitable.

Wheat Growing in Wyoming. The college department of the University of Wyoming has just issued a very important bulletin on wheat growing on the Laramie Plains. These plains are situated in southern Wyoming and cover one-half of the area of Albany County. It is a plateau of level land from 7,000 to 8,000 feet high and is surrounded by two ridges of mountains. The irrigation ditch from the Big and Little Laramie Rivers with their tributaries cover a large area of irrigated land, mostly along the streams, though the Pioneer Canal alone irrigates some 20,000 acres of the higher bench lands.

Experiments show that crops grow well at these altitudes when properly irrigated and cultivated. Corn does not grow well on account of the short season in these high altitudes, but wheat, oats and barley find a most congenial environment. The San Luis Valley produces large crops of excellent grain and supplies several large flouring mills and keeps them in successful operation. There are over 100 head of cattle and about 1,000 sheep for every ranch in Wyoming, yet most of the animal products used for food are of the packing house variety. To show how little the State has been developed and what great possibilities it possesses, it is stated that the value of the products raised in the State which is fed to live stock amounts to less than $1.00 per acre for all farming lands. Wherever irrigation is used, wheat produces large yields. It is necessary to irrigate wheat from two to four times, depending on the season, but the crop never fails. There is a large home market for wheat and the hi-products of the mills. The average yield is about twenty-five bushels per acre.

The only serious wheat pest found in southern Wyoming is smut, which is easily controlled by treating the seed. There is no doubt that Wyoming will within a very few years become one of the great wheat producers of the arid States.

Want to Buy Things. A number of letters are printed in this issue of The Irrigation Age from correspondents who are seeking machinery and implements of various kinds for irrigation and drainage work. The attention of manufacturers is called to these letters for the purpose of impressing upon them the absolute necessity of always keeping their business before the public. We have received a great many more letters during the past month, and they have been answered by letter. The letters we print are taken at random from the pile of correspondence received and show that buyers are always seeking the advertising pages of the journals devoted to the business in which they are interested for the things they want to buy. Manufacturers who are keenly alive to their interests will not neglect to keep their business always in the advertising pages of The Irrigation Age, because advertising is like bread upon the waters—it brings returns some times when least expected.

Miner's Carnival at El Paso. The International Miners' Association is preparing to give a great carnival at El Paso at the time of the National Irrigation Congress next November. The intention is not to have the two conventions at the same time, but one will follow the other closely enough so that persons who are interested in both may attend at the same time. It is believed that this Miners' Carnival will be a great benefit as giving irrigation delegates a good impression of the products of the mines of the Southwest and that capital may be interested in this industry which could not be reached by any other method. It has been suggested that a purse of $5,000 be offered for prizes in a drilling contest. There will also be displays of the work done by diamond drills, the electric and compressed air drills and all other forms of drilling. There will also be a miners' parade with miners in full working costume and an old-fashioned barbecue. There will be a great exhibit of mining machinery as well as the actual products of the mines. It is the intention to have the great copper mines of that region make fine displays of their ores and machinery, and large prizes will be offered for the best displays in order to induce interest in the carnival.

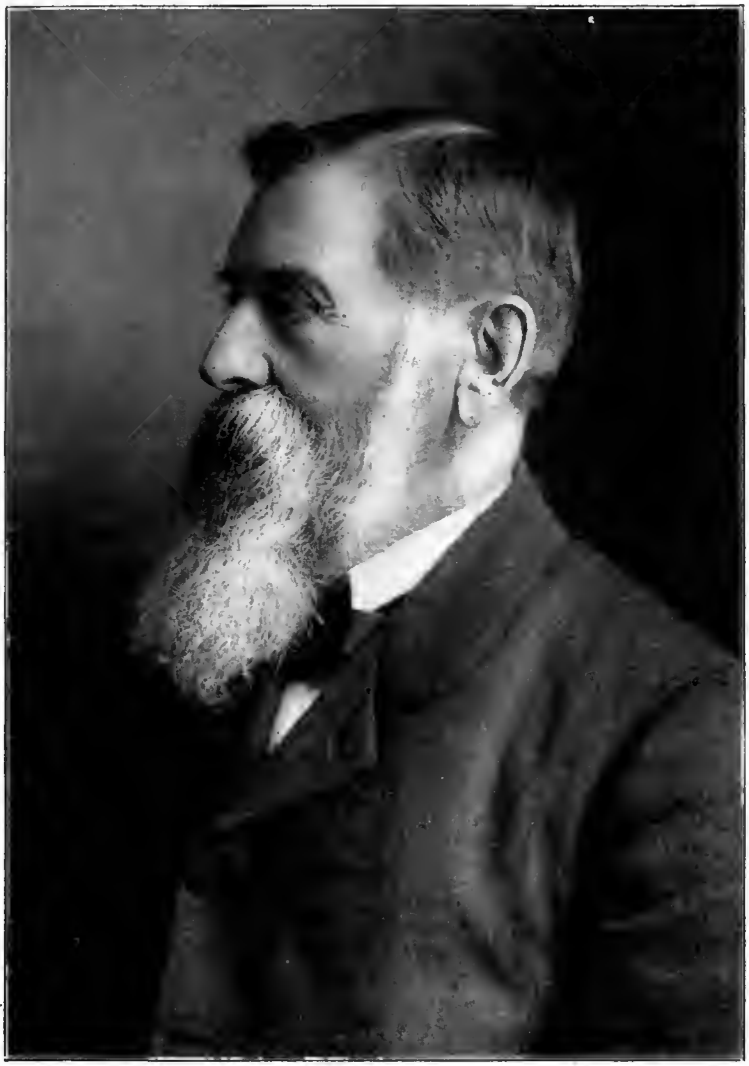
In answer to several correspondents who have made inquiries concerning the Iowa Drainage Convention held at Ames in January, we refer them to Prof. W. N. Stevenson, of the Agricultural College of Iowa, who will doubtless be glad to send all information regarding the convention that is requested.

THE ORIGIN OF OUR SOILS.

J. ARNETT.

While the earth spins upon its axis it waltzes around the sun in an elliptical orbit inclining at an angle of 23° 27′ 6″ 6 to the plane of the celestial equator, and which, perforce, it interesects at its ascending and descending nodes about the 21st of March and September respectively. These intersections are never at the same points in the earth's orbit, but have a retrocession westward of 50″ 1 of arc, and in consequence vast earth-involving changes running through a period of 25,868 years follow, and during which time each and every point in the earth's orbit has its perihelion and aphelion passage.

The reader may ask what has this to do with "the origin of our soils?" Let us see. The eccentricity of the earth's orbit is .016771, and taking the earth's mean distance from the sun at 92,790,000 miles we are 3,112,560 miles nearer the sun when the earth is at its perihelion passage, about December 21, than when at its aphelion, about June 21. What then? In going through the circuit above mentioned, the earth reached its aphelion passage in midwinter, far, far away from the sun, not an annual midwinter, but a midwinter extending through a period of 6,467 years. See, kind reader, the hand of the clock geologic points to the hour of eternal winter. Giant winter in his icy fetters holds universal nature bound, and death itself, with vitals frozen, lies prone at his feet. During these long and dreary winters the earth, away off yonder from the sun at its aphelion passage, snow, sleet and ice accumulated upon the north frigid zone to miles in thickness, feathering off toward the equator to about 40 degrees north latitude. And now what? This vast hood of snow, sleet and ice, in obedience to the centrifugal force exerted upon it by the rotation of the earth on its axis, outward flows in glaciers long, deep and wide. These glaciers pushed down mountains, filled up valleys and made the rough places plane. These glacial rivers scooped out the basins of the Great Lakes, tore up the solid bedrock and ground it to atoms beneath their omnipotent tread and pushed it in million-yard masses and moraines along their highway of march. The southerly or protruding tongues of these glaciers melted away in ocean gushes beneath the warmth of a more southerly sun, and these waters took the above finely-pulverized material and carried it here, there and yonder, while that falling in eddy places remained where it fell, and that falling on higher ground was oft claimed again by counter currents strong and borne away.



HON. C. W. MARSH.

Mr. C. W. Marsh, whose portrait is herewith shown, is one of the best known editors of class publications in the United States. Mr. Marsh has been editor of *Farm Implement News*, of Chicago, and one of its principal stockholders since the *News* came into existence, some eighteen or twenty years ago. He has been prominent not only as an editor, but at one time as one of the leading manufacturers of harvesting machinery in the world. He was for many years at the head of the Marsh Harvester Company, and, on that company going out of business, Mr. Marsh took up newspaper work and bas proven himself remarkably strong along these lines. His many friends will be glad to know that the newspaper venture has been exceedingly successful; *Farm Implement News* stands today as one of the best class papers published in America, both editorially and as a money-earner. The editor of THE IRRIGATION AGE was connected with *Farm Implement News* during its early history and was thereby brought into close contact with Mr. Marsh and the other members of that company, and it affords him great pleasure to be able to testify to the absolute uprightness of the gentleman, his sincere desire at all times to he fair and right in the editorial columns of his journal. It is thought fitting at this time to say a few words concerning Mr. Marsh, in view of the statement that he will within the next year withdraw from active work in connection with his paper and spend his remaining days at his comfortable country home, between Sycamore and DeKalb, Ill. The portrait shown of Mr. Marsh is the one from which a medallion was made at the time of the World's Fair, commemorating his participation in the development of harvesting machinery in America.

It is a law of matter that every molecule in the vast universe attracts and is attracted by every other molecule in inverse ratio to the squares of their distances asunder. This being true, this mighty hood of snow, sleet and ice, that weighted down the

arctic frizid zone and large part of the north temperate, exerted an attractive influence upon the oceanic waters, causing the flooding of the lands of the Mississippi Valley and long reaches of its tributaries. These incoming waters, coming from a warmer zone, increased the protruding glacial melting, and the constant change of trend of the current of the incoming floods increased the spread of silt. The poet says the mills of the gods grind slow, but grind exceeding fine. In this case the mills were mighty, and mighty the grist to be ground.

Let no one believe for a moment that the foregoing was the only source of our soils.

The volcano and earthquake deeply plowed the surface and the furrows they turned were craters, canons and mountain ranges. Air and water, world-building partners, decomposed in their laboratory the solid surface rock. The air in playful gale took up the powdered rock in clouds of dust and spread it far and wide. The water took up the coarser part and bore it to lower levels, where in chemical bath its reduction would be completed.

While the above glacial army, under the command of the world-building gods, was pushing down mountains, filling up valleys and scooping out basins of lakes and inland seas, its work, though great, ended at Cincinnati, Ohio, or about the fortieth parallel of north latitude. No trace of their handwriting is found south of Cincinnati.

But traces of changes equally stupendous are seen everywhere, showing that mighty degrading forces have been at work. The blue grass region in Kentucky owes its fertility to the melting down by decay of hundreds of feet of the solid surface rock, leaving standing here and there mounds hundreds of feet high and some of them acres in extent of the more obdurate rock that has so far resisted decay as silent witnesses of the changes that have taken place.

In Kentucky, Tennessee and the north ends of the gulf states the streams of drainage have cut down their beds in places 1,600 feet through solid rock. Volcanic ash, though sometimes sterile, belched forth in state-covering showers, often makes a fertile soil. To all of the above and more add decayed animal and vegetable matter and you have mainly the soils of today.

CITY ON A MOUNTAIN TOP.

Cloudcroft is situated on the top of the Sacramento Mountains in southern New Mexico, at an altitude of about 9,000 feet. Near the tops of the mountains the rain and snowfall is sufficient for the growth of crops, but it comes in the summer and winter, leaving the spring and early summer dry, and this, together with the cold nights, makes the growing season short. The only crops grown successfully here as yet are white potatoes and oat hay. In the canons at and below 7,000 feet, while the rainfall is less, there is considerable water, derived from springs, and this, if carefully used, will irrigate much of the area to which it can be applied. Here, in addition to potatoes, oats, barley, Indian corn, cabbage and other vegetables, and fruit are grown very successfully. Some persons have begun to grow berries and it is believed that this will prove to be one of the best small fruit sections of the territory. At the higher altitudes considerable attention has, in recent years, been paid to the growing of Angora goats, which seem to thrive particularly well there.

PROPOSE SENSIBLE CHANGES IN LAND LAWS.

President's Commission Adopts Many Suggestions of The Irrigation Age and Recommends Legislation Which Will Help the Settler.

The Irrigation Age feels justified in claiming a decided victory in the partial report of the special commission appointed by President Roosevelt to make suggestions regarding public land laws. This commission is composed of General Land Commissioner W. A. Richards, Chief Forester Gifford Pinchot and Chief Engineer F. H. Newell, of the Reclamation Service.

The committee recommends the outlines for a law permitting homestead entries upon agricultural lands within forest reserves, such entries to be located along the valleys on purely agricultural lands and not to extend to valuable timber on the hillsides. This is a wise and just provision, and The Irrigation Age has constantly urged that small farmers should be allowed to settle along the fertile valleys in the great forest reserves, which, when improved and adorned with homes, would only add to the attractiveness and value of the reserves.

The most important recommendation, however, and one which The Irrigation Age has always vigorously advocated, is an amendment to the commutation clause in the homestead law which will prevent timber thieves from annexing valuable timber lands under the pretense of settlement upon them for agricultural purposes. The abuse of this clause of the homestead law needed correction, and The Irrigation Age has always contended that it would be a simple matter to prevent it by proper legislation. The President's commission has taken the same view of the matter and recommends a change in the law which will prevent entries located within forest reserves or where the land is chiefly valuable for timber.

The report recommends the repeal of the timber and stone act, and provision for selling the timber on public land in large or small quantities as it may be needed for industrial purposes. While there seems to be no objection to such a provision, the meager report of this part of the commission's recommendation is not sufficiently clear upon which to form a correct judgment. If the Government goes into the business of selling timber lands, it will open up a great field for corruption, and the most careful safeguards to protect the interests of the Government should be provided.

The commission also makes the recommendation that when lands are restored to entry after temporary segregation, ample time should be allowed homestead entry men to exercise their rights, giving the preference over persons who may wish to select the land by the use of scrip or other form of entry. THE IRRIGATION AGE has made its fight chiefly upon the ground that if the commutation clause of the homestead law should be repealed entirely it would force homeseekers to buy their lands from the owners of scrip, who could spread it upon large areas of the most valuable agricultural lands in the West, and, together with the railroads, absolutely control all the land open to settlement, except those upon which settlers would be required to live five years.

The report of the commission is unexpectedly broad in its provisions, and the land-grabbing Octopus has evidently abandoned its efforts to carry out its schemes in their entirety, seeing that defeat was inevitable in the end. The report of the commission is a decided backdown from the arrogant stand hitherto taken by the Octopus, and THE IRRIGATION AGE congratulates the advocates of honest reclamation and correct principles in home-building upon this victory.

PROPOSED MINERS' CARNIVAL.

International Miners' Association Will Have a Grand Meeting at El Paso, Next November.

The El Paso *Daily Herald* says Secretary Gifford, of the International Miners' Association, has sprung a new idea on the members of the Association with reference to its next annual meeting.

At the last annual meeting of the Association it was voted to hold the 1904 meeting in Chihuahua during the month of January. However, believing that better results would be obtained to hold the annual meeting of the Association at the time of the National Irrigation Congress in El Paso next November and with this idea in view Mr. Gifford has been for the past few days calling on the different local members of the organization and getting their views on this matter and he has met with such favorable expressions that he is sending out printed circulars to the different members of the Association who live out of the city, asking for their views.

From the views of those who have already been approached on this matter there is no doubt but that the annual meeting will be held next November and that it will be one of the largest the miners have ever had.

The intention is not to have the two conventions at the same time, but one following the other closely enough to hold the crowds.

The possibilities along this line are great and Mr. Gifford believes by going ahead with the matter now and working with a view to having, in connection with the annual meeting, a miners' carnival, one of the most instructive and pleasing entertainments for the delegates to the irrigation congress can be arranged. Mr. Gifford's idea is not that of having an ordinary carnival with a lot of midway shows to flinch the people, but strictly a miners' carnival for the miners and their friends.

In this southwest region mining and irrigation are sister industries and while one would help the other, they are so different that neither one would conflict with the other. The miner has to depend on what is raised to support him, while in the end the man who raises his crops by irrigation has to a large degree to depend on the product of the miners' labor to pay for his crops, and if the two industries are developed in this section it will give the farmer an excellent market at home for his products and enable the miner to purchase his supplies without sending away for them.

The idea advanced by Mr. Gifford for the miners' carnival is something unique for this section and would, more than anything else, tend to give the irrigation delegates a good impression of the southwest and at the same time, no doubt, many of the capitalists, coming here for the irrigation congress, would become interested in the mining industry, who probably could not be reached by any other method, and thus new capital and brains would be brought into this section.

Mr. Gifford's idea of the miners' carnival, after consulting with the local members, is to have several attractions, including drilling contests, daylight and night fireworks, a miners' parade, a miners' trades parade, a big barbecue, machinery displays and a display of ores.

"My idea is first to have one of the largest drilling contests that has ever taken place," says Mr. Gifford in explanation. "I would suggest that a total purse of about $5,000 be hung. In addition to the hand drilling we should also have a display of the work done by the diamond drills, the electric and compressed air drills and all other forms of drilling.

"Then we would want a miners' parade by all means, where the miners from all over the country could appear in working costume, carrying their candles on their caps and their picks and shovels over their shoulders. In connection with the miners' parade we would also have a miners' trades display to be fitted out by the local mechanics, which would fittingly illustrate the growth of the mining industry of the southwest.

"Instead of the customary banquet I would suggest an old fashioned barbecue. The average miner does not always feel at home in a banquet hall, while at a barbecue he would be comfortable.

"By taking hold of this matter in an energetic manner one of the greatest attractions ever seen in the southwest can be arranged. The large mining machinery houses in the East are continually sending machinery through the city to the different mining camps and by taking the matter up with them at once no doubt many of them could be induced to have some of their machinery on exhibition here at the time.

"Along with the machinery exhibit a fine exhibit of the actual products of the mines and treating plants of the southwest could be secured, as it would be an easy matter to induce such companies as the Copper Queen, Calumet & Arizona, The Cananea Consolidated, and the Arizona Copper Company to stop a carload of bullion en route east and place it on exhibition here."

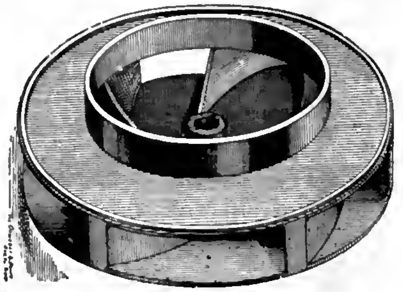
HISTORY OF PUMPING WATER.*

Wonderful Development of Plants for Irrigating Purposes and Their Use in New Mexico.

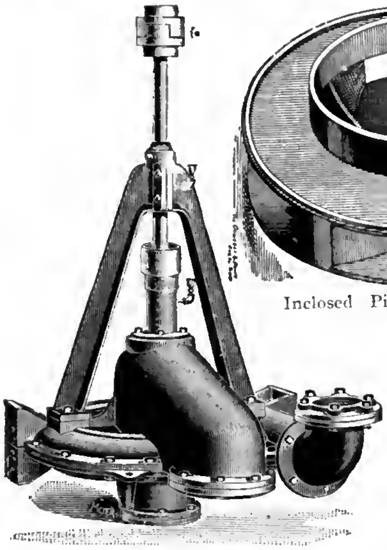
BY JOHN J. VERNON AND FRANCIS E. LESTER.
New Mexico College of Agriculture.

[Continued from February number of THE IRRIGATION AGE.]

The illustration of Van Wie centrifugal pump shown in these columns, also cut showing the inclosed



Inclosed Piston, Van Wie Pump.



Van Wie Centrifugal Pump.

piston used in this pump, should have appeared in connection with our February installment of "History of Pumping Water." This was not possible, however, owing to the fact that these cuts were not in our possession at that time. This pump is made by Irvin Van Wie, Syracuse, N. Y.

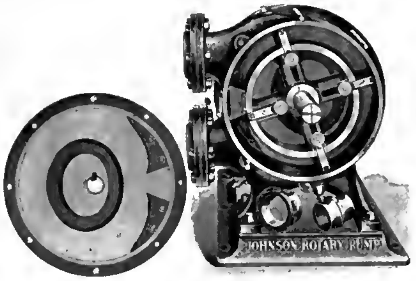


Fig. 28. Interior view of Johnson Rotary Pump, shown in Fig. 27.

The Johnson rotary pump, illustrated in Figs. 27 and 28, is of the front, single-suction, belted type, made by the Davis-Johnson Company, 41 West Randolph street, Chicago, Ill. A No. 5 pump, fitted with five-inch suction and five-inch discharge pipes, was tested. Fig. 29 illustartes the discharge thrown by this pump from a five-inch pipe, 330 gallons per minute.

The results of the test are given below: Gallons per minute 322; speed of pump, 125 revolutions per minute; time run on one-quarter cord wood, 4 hours 30 minutes.

This pump was put in a second time, fitting it with six-inch suction and six-inch discharge pipes. There was no material change in the results.

* From Bulletin No. 45, issued by the New Mexico College of Agriculture and Mechanic Arts, Mesilla Park, N. M.

PUMPING PLANTS IN NEW MEXICO.

Comparatively little has been done in New Mexico in the way of irrigating lands from wells by means of pumping plants. The statistics for the census of 1900 show that only 1,004 acres of land in New Mexico are irrigated from wells, as against nearly 203,000 acres which are irrigated from streams. The irrigation from wells so far practiced in New Mexico has been confined to the few farmers who have practiced irrigation in this manner from small plants when they have had no other source of water, or as a means of supplementing the regular supply when the latter fails, and in most of these cases the plants have been operated by windmills. The practice of irrigating from wells is in its infancy in our own territory and the possibilities of the work appear not yet to have been generally recognized by our citizens.

Although not in New Mexico, the conditions existing near El Paso, which is less than thirty miles from the southern border of our territory, deserve some notice. The experience of the farmers in that region is of some value. Through a constant failure of the regular supply of the irrigating water from the Rio Grande the farmers of that locality have been compelled to turn their attention to other water supplies or else abandon all agricultural work. As a consequence they have demonstrated the fact that crops can be profitably grown by irrigation from wells tapping the underflow in the Rio Grande Valley. Some of these plants have been in operation for several years past and by statistics secured it is shown that the work is a profitable one. The conditions there are almost exactly similar to those prevailing over a large part of the Rio Grande Valley, and it is largely because the river water has failed in that region that the work of irrigating by means of

Fig. 29. Discharge of about 330 gallons per minute thrown from a five-inch pipe by Johnson Rotary Pump No. 5.

pumps has been more fully developed than throughout the Rio Grande Valley generally of New Mexico.

The tables presented herewith upon the wells and pumping plants of New Mexico and the Rio Grande Valley show comparative statistics which have been secured by personal investigation and by extensive correspondence with the owners of such plants. Some

of the most valuable data received regarding wells in New Mexico has been gained through the experience of the Santa Fe Railway Company in sinking wells for the necessary water supply along its line in our territory and a separate table is made on this subject. (See Table 13.) The tables show, further, the comparative conditions existing in our territory and in other regions from which data has been secured.

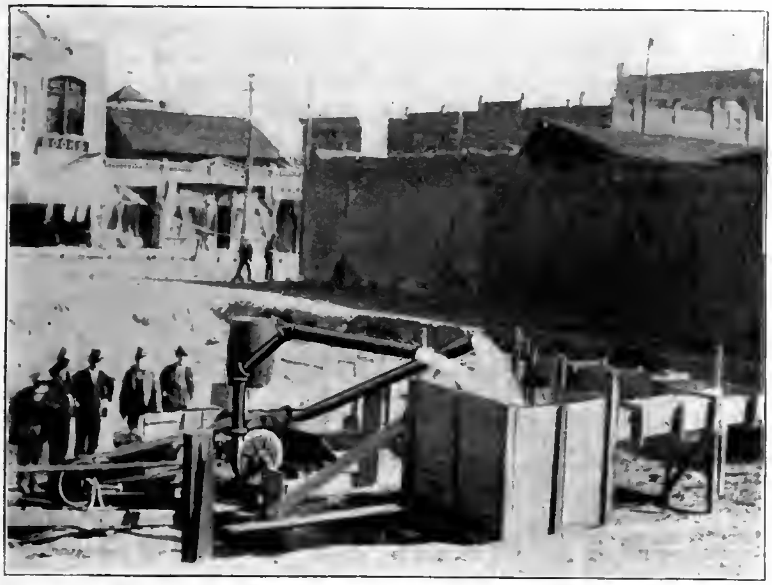


Fig. 30. Competitive test of pumps at the El Paso (Texas) Carnival, January 18, 1902. Water pumped from open tank, with lift of nine feet. Slanting pipe from six-inch Johnson Rotary Pump discharging 700 gallons per minute; horizontal pipe from six-inch Byron-Jackson Centrifugal Pump discharging 800 gallons per minute.

PUMPING PLANTS IN OTHER STATES.

For the purpose of presenting comparative data in this bulletin, a systematic correspondence has been conducted, by means of which statistics concerning pumping plants in other parts of the United States have been secured. In gathering and compiling these statistics representative cases, so far as possible, have been taken, and the reader is thus enabled to compare in the same table relative figures as to the cost and the utility of plants as they exist in various regions.

California leads all other States in the number of acres irrigated from wells. The last census shows that a total of 152,506 acres of land were in 1899 irrigated from wells, or more than 10 per cent of the total acreage irrigated in that State. Colorado comes next, with a much lower percentage, 7,050 acres irrigated from wells. From these two States representative cases have been used in the compilation of the tables presented herewith. In Louisiana and east Texas the recent development of the rice industry has been the reason for the irrigation of enormous tracts of land by pumping plants. Most of these are operated on very low lifts from beds of water under different conditions from those which must prevail in our territory. Through the higher lands, however, pumping is practiced for the irrigation of rice and other crops from deep wells, and a few instances of this kind have been compiled in the tables shown.

RELATIVE CONDITIONS IN THE RIO GRANDE VALLEY.

It may not be amiss in this bulletin to call attention to the conditions in the Rio Grande Valley for pumping for irrigation as they compare with other States and regions. In the pumping of water for irrigation the most important consideration is a large available amount of water at a reasonable depth. From this standpoint alone it becomes apparent to the person who gives any thought to the matter of comparative conditions that hardly any, if any, other locality can show better advantages than the Rio Grande Valley. Water throughout the valley in large quantities may be secured anywhere below a depth of from fifteen to twenty feet and the whole valley appears to be underlaid by, so far as we know, an almost inexhaustible supply of water. This water is of good quality and occurring at so short a distance below the surface of the ground may be raised very economically. It appears probable that in almost any part of the valley sufficiently thick beds of water bearing gravel may be met with to allow the placing of a strainer such as that used in the station well. This being so, it makes unnecessary the expensive strainers that are used in some regions to secure water from sand. The cost of the construction of a well need not be heavy. The work of the experiment station appears to have demonstrated the fact that with a well costing from $100 to $200 an ample supply of water may be secured for the irrigation of a farm of 100 acres or more.

Fig. No. 36. Discharge of about 450 gallons per minute thrown from a five-inch pipe by a Byron Jackson No. 4 Centrifugal Pump—E. Stoney, Porcher, El Paso, Tex.

Probably no part of the country has been more often referred to for successful examples of profitably

pumping for irrigation than southern California. The Rio Grande Valley possesses many advantages which southern California has not and lacks few that are possessed by the Golden State. Many of the wells from which water is pumped for irrigating purposes in California are several hundred feet deep and sunk at an expense for original cost far greater than is necessary in this valley. Land is many times more expensive in California than here and labor much more costly. The prices received for products are about the same in both California and New Mexico and the matter of markets, with proper development, ought to be extensive enough in this territory to take care of all the products that can be raised. We can, however, learn from the California irrigator the lesson of economical methods and the proper use and duty of water.

A comparison of the conditions existing in the valleys of New Mexico in which irrigation by pumping can be practiced can not but inspire faith in the great possibilities of our territory in any one who will carefully study the question.

PUMPING PLANTS AND CO-OPERATION.

Pumping plants resolve themselves into two classes, namely, co-operative and individual plants, in each of which there is much of merit. The former may be defined as a pumping plant from which two or more farmers may obtain water, while the latter refers to pumping plants located upon each farm under individual control and supplying individual needs. The moment the control is divided or there is a division of water, however obtained, the plant passes into the co-operative class, though it may be a modified form of co-operation.

A co-operative plant, wherever located, for obvious reasons should render the maximum of efficiency and economy of production. Objections which might justly be made against a large plant located at the head of a ditch are:

1st. The difficulty and great cost of developing water at one place in a sufficiently large quantity.

2nd. Opportunities for misappropriation and waste of water.

3rd. Loss of water by seepage and evaporation.

4th. Making and maintaining a just and equitable division of the water.

The same objections, in a much modified degree, might be raised against plants so placed as to supply only a small number of shareholders. With a few shareholders, however, it would be a much easier task to divide the water properly and there would be far less danger of misappropriation.

Size of Farm Irrigated by Varying Quantities of Water.

Showing the acreage of land that can be irrigated by a given quantity of water (from 600 to 2,000 gallons per minute), pumping 10 or 24 hours a day, and irrigating every 10, 14, 21 or 30 days.

Gallons Per Minute.	Number Hours Run.	Irrigated Every 10 Days.						Irrigated Every 14 Days.						Irrigated Every 21 days.						Irrigated Every 30 Days,					
		1 inch deep.	2 inches deep.	3 inches deep.	4 inches deep.	5 inches deep.	6 inches deep.	1 inch deep.	2 inches deep.	3 inches deep.	4 inches deep.	5 inches deep.	6 inches deep.	1 inch deep.	2 inches deep.	3 inches deep.	4 inches deep.	5 inches deep.	6 inches deep.	1 inch deep.	2 inches deep.	3 inches deep.	4 inches deep.	5 inches deep.	6 inches deep.
600	10	132	66	44	33	26	22	185	92	61	46	37	31	277	138	92	69	55	46	396	198	132	99	79	66
	24	318	159	106	79	63	53	445	222	148	111	89	74	668	334	222	167	133	111	954	477	318	238	191	159
824	10	182	91	60	45	36	30	255	127	85	63	51	42	382	191	127	95	76	63	546	273	182	136	109	91
	24	437	213	145	109	87	73	611	305	204	153	122	102	917	458	305	229	183	153	1311	655	437	327	262	218
944	10	208	104	69	52	41	34	291	145	97	72	58	48	437	218	145	109	87	73	624	312	208	156	125	104
	24	500	250	167	125	100	83	700	350	233	175	140	116	1050	525	350	262	210	175	1500	750	500	375	300	250
988	10	218	109	72	54	43	36	305	152	101	76	61	51	458	229	152	114	91	76	654	327	218	163	131	109
	24	524	262	174	131	104	87	733	366	244	183	146	122	1100	550	366	275	220	183	1572	786	524	393	314	262
1000	10	221	110	73	55	44	37	309	154	103	77	62	51	464	232	154	116	93	77	663	331	221	165	132	110
	24	530	265	176	132	106	88	742	371	247	185	148	123	1113	556	371	278	222	185	1590	795	530	397	318	265
1200	10	265	132	88	66	53	44	371	185	123	92	74	62	556	278	185	139	111	92	795	397	265	198	159	132
	24	636	318	212	159	127	106	890	445	297	222	178	148	1335	668	445	334	267	222	1908	954	636	477	381	318
1500	10	331	165	110	82	66	55	463	231	154	115	92	77	695	347	231	173	139	116	993	496	331	248	198	165
	24	795	397	265	198	159	132	1113	556	371	278	222	185	1669	834	556	417	334	278	2385	1193	795	596	477	397
2000	10	442	221	147	110	88	73	618	309	206	154	123	103	928	464	309	232	185	154	1325	662	441	331	265	221
	24	1060	530	353	265	212	176	1484	742	495	371	297	247	2226	1113	742	556	445	371	3180	1590	1060	795	636	530

NOTE. In the above computations all fractions below .8 have been dropped.

Perhaps the strongest objections that can be made against individual plants are: 1st, a relatively large initial cost of installation, and second, a low rate of efficiency and economy. However, the individual pumping plant has advantages that should not be overlooked. They are: 1st, misappropriation of water is impossible. The water is developed upon the farm where it is used and therefore at all times is within the domain and under the control of its owner. 2nd, loss by evaporation and seepage is minimized. 3rd, there is no division of water and, therefore, injustice from a lack of equitable distribution is entirely eliminated. 4th, there are no long ditches to maintain at great cost, and, 5th, the initial cost is within the means of every farmer.

The writers, however, believe that a combination under favorable circumstances of these two systems will prove not only satisfactory but at the same time the most economic method of producing large quantities of water for irrigation during droughty periods. This combination consists in the maintenance of individual pumping plants upon each farm, thus se-

curing all the desirable features of such plants as heretofore enumerated, and at the same time eliminating the objectionable points proposed against a single large pumping plant at the head of a ditch; in conjunction with these a centrally located electrical power plant, through which the farmer would receive the benefits of efficiency of control and economy of production which such a power plant should give.

Fig. 32. Discharge of about 450 gallons per minute through a six-inch pipe from pump of J. Stoney Porcher, El Paso, Tex.

Another suggested plan is to maintain along the line of a ditch, at suitable distances apart, pumping plants of sufficient capacity to supply the land to be watered from each, such plants to be operated by a central electrical power plant; and there would seem to be nothing to prevent a successful working of this plan.

COST OF A PUMPING PLANT.

Under a system of co-operation a pumping plant should not cost each farmer more than $350 to $400. This figure includes the two items of well and pump. If, however, an individual pumping plant is to be installed, to the items of say $200 for the well and $200 for one of the pumps, giving the best results in the test, the cost of an engine must be added. This will be found the most expensive item. Engines, both steam and oil combustion, vary considerably in price, and, therefore, it is impossible to give definite figures on the cost. An engine large enough to furnish power for pumping 1,000 gallons per minute would probably cost from $900 to $1,500, depending upon the make. It is probably safe to say that for supplying water for large areas an individual pumping plant would cost not far from $10 for each acre of land irrigated.

CARE OF BOILERS, ENGINES AND PUMPS.

By J. S. MacGregor, Assistant in the Department of Mechanical Engineering.

The following general statements on the care and operation of boilers, engines and pumps are intended for laymen, and if carefully adhered to will add to the life, safety and economy of pumping plants.

Before firing see that there is a moderate supply of water in the boiler. The fire should then be raised gradually, so that the metal in the shell may expand evenly. Next regulate the feed pump, or injector, to supply water as steam is used. Keep the wood or coal spread evenly over the grate, and do not allow the grate bars to become bare, as cold air will rush in and cool the heating surface. The thickness of the fire will depend on the draft; if the draft is strong the fire should be heavier than if it is weak. When burning wood maintain a bed of live coals about three inches deep, with plenty of wood on top to maintain this thickness. In order to clean the fire push the upper part of the fire to the back of the grate, remove the ashes and cinders,

Fig. 31. A Gould's Endless Chain Bucket Pump used by Mann Bros., of Albuquerque, for Irrigating.

then pull the fire forward and draw the ashes and cinders of the back over the fire into the ashpit, distribute the fire evenly over grate and add new fuel. If burning soft coal break the fire up occasionally with a bar, as it has a tendency to crust on top. Do not allow the ashpit to become full of ashes, as there is

Fig. 33. Discharge of about 500 gallons per minute through a six-inch pipe from pump of E. J. Hadlock, El Paso, Tex.

danger of burning out the grate bars in such case.

When working with fire or firing, do so as quickly as possible, for cold air rushing in not only cools the boiler, but also causes uneven contraction in it, and uneven contraction and expansion of the shell and tubes of a steam boiler do it great injury. Leakage and cases of rupture are often caused by forced heating and cool-

ing. Be moderate in everything that tends to change the temperature of the boiler. The safety or pop valve should be raised once or twice a day when under pressure, doing so very gently to make sure it is in working order.

Sediment collects in all boilers, due to the precipitation of solid matter in feed water used. This sediment forms a scale, and the presence of a scale results

No. 34. Irrigating ditch filled by pump of E. J. Hadlock, referred to in Plate 33.

in fuel loss. It has been estimated that one-sixteenth inch causes a loss of 13 per cent of fuel, one-fourth inch 38 per cent and one-half inch 60 per cent. Further, the circulation of water in the boiler causes loose particles of this scale to be deposited in some one place, which is generally over the firebox. This place becomes overheated and results in "bagging." In order to avoid the accumulation of sediments, with the resulting evils, open the manhole and clean the boiler out occasionally; or boiler compounds may be used which aid in decomposing the scale.

THE ENGINE.

The following directions pertain to the ordinary types of stationary steam engines: Before starting the engine oil up all around and see that the cylinder lubricator is in working order. Then open all drain cocks, open throttle valve slightly and allow the steam to warm the walls of the steam chest and cylinder. Now start the engine slowly and allow it to run a few minutes before closing the drain cocks, for if drain cocks are closed too soon water will collect in the cylinder and either split it or burst out the head. During the run feel the bearings occasionally and avoid all lost motion by keeping parts well tightened up.

On closing down first open drain cocks, then close throttle slowly, allowing the engine to slow down gradually. Never open or close the throttle valve quickly. If any unusual noises occur during the run, close down immediately and investigate. Clean off the engine thoroughly after each run. It pays to use a good quality of cylinder oil. Give the cylinder oil in quantities of about one drop a minute.

The method of starting and stopping gas and oil engines vary so much with different makes that we have not enumerated them here.

PUMPS.

In order to start a centrifugal or rotary pump it is first necessary to raise the water into it. This can be done by use of the ejector when in connection with a steam plant. To do this, close the mouth of the exhaust water pipe by some convenient means, a good way being to place a piece of soft leather, stretched on a board, over it. Now turn steam through the ejector; this will exhaust the air and raise the water into the pump. When this is done start the engine, gradually coming to speed. If the pump is run by a gas or oil engine, an ordinary hand pump may be used to raise the water. During the run keep the bearings of the pump and counter shaft, if any, well oiled. Feel each occasionally. Keep the belts in good condition and avoid slippage by the use of belt dressing. A pump fails because it leaks; there can be no other reason; find the leak and repair it. Leaky valves can be repaired by grinding valve seats. Always drain the pump in cold weather, for water remaining in it will probably freeze and either loosen joints or burst the pump. Lastly, always keep material for gaskets and packing on hand.

LA JARA AN IDEAL LOCATION.

Beautiful Farming Country in the Great San Luis Valley in New Mexico.

La Jara is a farming town located eighteen miles north of New Mexico line on the Denver & Rio Grande railroad in the San Luis Valley. It has an elevation of a little over 7,000 feet. The surrounding country for miles in every direction is practically as level as a floor, sloping only a few feet to the mile, and to the inexperienced every way looks like down hill. The country, however, slopes gradually to the northeast—the general course of the streams, which are the San Antone, Rio Conejos, Rio La Jara and Alamosa rivers. The entire country surrounding La Jara is underlaid with artesian water that is as pure and free from mineral as man ever drank and of a temperature of 48 degrees Fahrenheit, winter or summer. This water is obtained at a depth of from forty to sixty feet and numerous other flows on down to several hundred feet. The valley is underlaid with one great reservoir of pure water for domestic, stock and agricultural purposes. It has not, however, been used for the latter purpose, owing to the abundant supply of river water for irrigation purposes, the latter being more desirable, as a sufficient head can be more easily obtained in that manner.

The principal crops are oats, wheat, barley, potatoes and peas. Small fruit does well. The cereals yield from thirty to 100 bushels per acre. Peas are generally pastured when ripe, netting in that manner about $30 per acre as hog or sheep feed. The country is just now in a transitory period, changing from a stock to a farming country, and the next few years will witness a great development in a farming way. A great many Eastern farmers have settled near La Jara in the last few months and development of town and country is progressing rapidly. La Jara has a mill and elevator of 250 barrels capacity, but it is inadequate to handle the supply of grain marketed there. There are four general stores, two exclusive hardware stores, two meat markets and groceries, one drug store, one furniture store and one harness shop. La Jara has also fine churches.

IRRIGATION IN BRITISH INDIA.

Remarkable Development in the Region of Hyderabad, Deccan, Described by a Native Engineer.

BY H. DINSHAW.

NALGUNDA, NAKRAKAL, DECCAN, INDIA, December 15, 1903.—Amongst the several existing native states in British India the country of H. H. the Nizam of Hyderabad, is the largest in extent and population. Situated on the plateau of the "Deccan," it is divided into two main divisions, locally known as the Marathawari and the Telingana. The division is ethnological as well as physical. The Marathawari division, according to the census of 1901, has an area of 43,216 square miles, with a population of 6,386,895, and is inhabited by the Maratha speaking races, while the Telingana has an area of 39,482 square miles with a population of 4,788,002, inhabited by the Telegu and Kanarees speaking races. The continued area of the two divisions is equal to about that of North and South Carolina taken together, while the total population is about 730,000—more than that of the South Atlantic States of the Union.

H. DINSHAW, C. E.
In charge of irrigation work in the Nalgunda District of Telingana, India.

The historical importance of Hyderabad dates from 1713 A. D., though the city was founded as far back as 1589; but up to the time Sir Salar Jung, the greatest of India's native statesmen (1853-1883) assumed office of the prime minister the condition of the Nizam's state was a very deplorable one. Immediately Sir Salar Jung secured himself in office he commenced a series of reforms, taking for his models those already introduced by the British Government throughout India. The state may since be considered to have been on the way of steady progress, and now it stands as one of the most enlightened among the other native states. It was Sir Salar who opened out the country and joined it with the most civilized centers of the British India by railroads. At the present day we have 715 miles of opened line and a good length under construction and surveys. The history of the progress of irrigation also dates from Sir Salar. In the present article the writer attempts to trace the progress of irrigation from its earliest time to the present day, and view the prospects of its future development within this state.

The bulk of the population of the Hyderabad state is purely agricultural. Out of the yearly revenue of 40,000,000 rupees [3⅛ rupees equal one dollar] half is collected from the land assessment only. Individually the ryot is poor and illiterate and has small holdings, especially in the Telingana division.

Before proceeding any further it will be well to examine the physical differences which distinguish the two divisions. The Marathwara, mostly a plain tableland of rich black soil formed by the decomposition of the trappean rock, needs no artificial aid of irrigation to mature a healthy crop. The annual rainfall, which in these parts averages 37.63 inches, is quite sufficient for the purpose. In the Telingana division the soil being of red, gritty mold, is partly impervious to water, and so readily gives up its moisture that the cultivation depending upon the yearly rainfall is productive of a small and poor crop. In many parts, however, the soil when left uncultivated is soon covered up with a low shrub jungle which in time turns into a forest. The rivers in Marathwara are more or less perennial and even in the hottest weather a decent flow is continued. Such is not the case in the Telingana division, unless the river passing through it has its origin in the Marathwara country. This state of things in the Telingana division demands the storing up of water running through the drainage of the country for the purpose of cultivation, and the efforts of the rulers of Telingana have from time immemorial consisted in the great development of the resources of irrigation.

Fortunately in Telingana these resources are many. The streams running into the valley of great rivers, the rivers themselves and the natural configuration of the country all afford easy means of storing water and conveying it through channels to lands for cultivation. The majority of tanks and irrigation systems of these dominions is of Hindu origin. They were undoubtedly constructed by the rajahs of Warrangal, the capital of the Telingana division founded by the Narapati Andhras prior to the year 1294 A. D. Without the aid either of the level or the compass they excavated miles of channels to supplement the waters of the large reservoirs they had already constructed. The principal features of their tanks were to form one by damming up a narrow valley with a huge earthen bank strongly protected against the wave action on the water side with a thick layer of revetment, in some cases exceeding a yard in thickness. Little or no consideration was given to the surplus discharge from the tank's catchment area, being got rid of without overtopping the bank. The idea throughout seems to have been to store every drop of water received from it. The banks were for the latter reason made very high, in some cases over eighty feet, with flat slopes having a top width varying from six to fifteen feet. A rude contrivance to draw water for cultivation was invariably made by a small masonry tunnel underneath and across the bank.

The principal causes of the failure of these works are the inadequate surplus arrangements, the bursting of the sluice tunnel by an excessive velocity caused by the issuing volume of water with a large head; the inferior earth used in the formation of the bank; the

relative number of masonry works on the tanks constructed by them are of inferior workmanship and in almost all cases without any pretension to elegance of form or the beauty of structure. The channels, either taken from a river to feed a tank or for cultivation, have generally a great fall. The alignment is mostly tortuous and not devoid of sharp curves. In almost all cases the channels are taken off from a river without any head works or regulating arrangements. Where the channel crosses the natural drainage of the country, no masonry works for passing the surplus are provided. High earth mounds are thrown up, trying to block the stream at the entrance, as a consequence of which the drainage, finding its way by a circuit, enters the channel ultimately at another point and makes a new entrance, which in course of time, working against the channel banks, breaches them by overtopping. The maintenance charges of keeping these channels working must have been very heavy. The lowest class of the ryots, called Dheds, of a village had lands free of any assessment under certain irrigation systems, who for the free gift had to clear every year the channel of its silt, etc., before the rains set in.

The diversion dams on rivers from where long lines of channels are taken are constructed of cyclopean stones of great breadth, mostly founded on rock. These dams are in all cases not high and are of a serpentine form. The Indian rivers carry a considerable amount of sand and other debris, so that the old dams have now been silted up right to the top. Their ultility is therefore greatly lessened and very little flow at ordinary freshets passes down the channel. The use of a scouring sluice to avoid this evil does not seem to have been understood by the ancients. No irrigation sluices are provided in channel banks, but water is taken by a small cut in it. Owing to the entire absence of proper regulating arrangements for the distribution of water, both from the tanks and the channels, the wastage of water from them in olden times must have been enormous, and up to the present day great trouble is experienced by the irrigation officers to prevent this willful waste on the part of cultivator. The quantity of water required to mature a rice crop in the Nalgonda district of the Telingana division is estimated at 120,000 cubic feet per acre for a season, but in a certain case as much as 247,158 cubic feet per acre was used.

To sum up, the irrigation works of the old Hindu rajahs show to a marked degree the utter disregard of all knowledge of hydraulic principles. The reasons why some of their works are working to the present day is to be found in the fact that their successors, the Mohammedan rulers, spent large sums of money every year to maintain them. The original cost of construction to the rajahs themselves must have in itself been a great one, as most of their gigantic works, with our present knowledge of the principles of irrigation, could have been very economically constructed.

With the advent of the Mohammedan rulers in the beginning of the sixteenth century up to very late few new irrigation works were constructed. The efforts of the Mohammedan kings were mainly directed toward repairing ruined works of their Hindu predecessors or maintaining those constructed by the latter in an efficient state of working. But after the conquest of the "Deccan" by Aurazeeb, when, consequent upon the confusion and anarchy into which whole India was thrown at the decline of the Mogul empire, all progress was at a standstill, and naturally the irrigation works in Hyderabad came also to be neglected, so that they very rapidly came to grief one after the other. When, therefore, the Nizams got possession of the country, in 1714 A. D., most of the magnificent old tanks and irrigation systems had already ceased to work.

As stated before, up to the time Sir Salar Jung assumed office of the prime ministership of Hyderabad in 1853 and insured for it a state of peace and tranquillity long unknown in the country, the irrigation works received no attention. Sir Salar, having first succeeded in dividing the country into sixteen convenient districts and appointing a collector for each, in 1865 regulated the administration of the dominions, instituted courts of justice, and then directed his attention to the means of furthering the general advancement of the country. In Telingana he soon saw that the only means of ameliorating the condition of the cultivators was to restore the old irrigation works. In 1867 he founded a public works department, and entrusted to it, among other things, the restoration of the irrigation works. From that year up to 1886 the public works department received grants of money simply to look to the normal wants of the Telingana country, which only just sufficed. To save the existing revenue from irrigation works in the Teligana division a board of irrigation was now created, of which the chief engineer was also a member. Eight distinct survey parties were immediately formed with instruction to survey works as may be directed by the board and furnish plans and estimates for its sanction.

The board had extensive powers of according sanction to carry out large works, and rapid progress was soon made. The board was, however, abolished in 1893, and the prime minister himself considered all projects and sanctioned large sums of money toward irrigation works. The irrigation department, with the increasing amount of its work, now required the services of a special chief engineer to properly control and direct it. In 1895 it was therefore separated from the public works department and the Nizam's government applied to the government of India for the services of an experienced irrigation officer to take charge of the department. The services of Mr. J. H. Medlicott, M. T. C. E., from the Madras presidency, was lent to the Hyderabad state through the courtesy of the government of India. The irrigation features of the Madras presidency closely resemble those of Hyderabad; and, coming from the former, Mr. Medlicott was well suited for the post. He was, however, soon recalled by the British government, as his services were required for special duty outside of India.

To replace Mr. Medlicott the next selection of government of India fell on Mr. P. Roscoe Allen, M. T. C. E., also of Madras service. He assumed charge of the office of chief engineer for irrigation on January 3, 1898. The five years of his tenure of this office are a remarkable epoch in the history of irrigation of Hyderabad, and we have, therefore, to examine at some length the progress made during the period of 1898 to 1903.

Mr. Allen was a man of untiring zeal and energy, and he did for Hyderabad that good which no other man with his opportunity and time was able to accomplish for it. He recognized the vastness of the work entrusted to him and the scanty help he had at his disposal to be able successfully to cope with the subject. The irrigation staff, especially in the subordinate

grade, was weak and small; with their help he anticipated progress very slowly, and therefore set to move the government to import a large number of well-qualified men from outside Hyderabad. Here he did not succeed, for, according to a recent government resolution, no outsider is allowed to be employed (except in extreme cases) in the service of his highness the Nizam. An engineering school, which was not founded on the best basis, did exist in Hyderabad, which imparted instruction to the natives to qualify them as supervisors and surveyors. This he strengthened and improved to suit his requirements and made it a feeder for drafting young, healthy and properly trained men into the irrigation department. When he assumed office few works were in progress and less estimates were ready to start new ones. What, then, was needed was a large survey party to investigate and speedily prepare estimates for the restoration of old, ruined tanks. Being an excellent administrative officer, he so distributed the existing staff and quickly disciplined the members, that in a year's time he had sufficient estimates to make a good start, and this start was made in earnest.

All public works department works are here carried out by contract agency, the contractor monthly receiving payments in cash for the amount of work turned out by him. A little before Mr. Allen took charge a system of payment called "the new scheme" was introduced, by which a contractor agreed to carry out an irrigation work as provided in the sanctioned plan and estimate at his own cost. His entire outlay, together with interest at 5 per cent per annum on it, being reimbursed to him from the accruing revenue under the tank or system, restored or repaired by him. Though a great number of works were let out under the system, the progress was very slow, as the contractor naturally executed only such immediate repairs as would make the work paying and proceeded with the other repairs at a rate proportionate to the portion of his reimbursed outlay. Thus a work which would have, in the ordinary course of things, been completed in a year was allowed to drag on for three and four. The scheme was abolished in the commencement of the current year and all works are now carried on by cash monthly payments only. Mr. Allen soon personally acquainted himself with the whole of Telingana division by long and extensive tours throughout the irrigation districts. The number of useful irrigation projects investigated in his time is great and those under construction are many.

If for the sake of convenience the thirty-six years of the existence of Hyderabad public works department be divided into three periods and a comparison be made of the average annual expenditure on irrigation works, the following table indicates how Mr. Allen had labored within the term of his office to raise the irrigation status of these dominions and how admirably well he succeeded:

Name of Period.	Duration.	No. of Years.	Aver. Expenditure on Works Per An.
1. The Anti-Irrigation Period	1867-1887	21.	292,188 Rupees
2. The Irrigation Period. ..	1888-1897	10.	483,602 Rupees
3. The "Allen Period"......	1898-1902	5.	1,200,438 Rupees

The proportion of expenditure on establishment before Mr. Allen took charge was as great as 42.4 per cent. In 1902 he reduced these charges to 21.1 per cent.

The average amount of estimates per annum prepared by the department during the third period was 29,931,861 rupees.

Mr. Allen, for the convenience of working the irrigation projects, classified all works under four heads:

Major works: Class 1—Restoring abandoned works. Class 2—Restoring recently damaged works. Class 3—Extending and improving existing works.

Minor works: Class 4—(A major work irrigates above and minor below 100 acres).

Figures for the new increase in revenue on account of irrigation assessment on lands brought under cultivation by the operations of the department during the third period are not available to a degree of accuracy for each year. But for 1900 A. D. they are, and give a return of 10.5 per cent from all classes of works on the outlay. The whole of the third period covered a cycle of bad years as regards the rains, and consequently the returns are poorer than they would have been in more favorable years.

The area of new land that will be brought under cultivation by the operations of the irrigation department in the third period will be about 400,000 thousand acres, as detailed below:

1. By works already sanctioned and under construction 214,734.75
2. By works under sanction............. 52,271.50
3. By works under survey...............132,993.75

The minimum rate of assessment of wet lands prevailing in the irrigation districts for an acre is fixed at 8 rupees per acre for a crop, and with these low figures the annual revenue that will accrue to government will be about 3,250,000 rupees from the above acreage.

Up to the arrival of Mr. Allen as chief engineer the plans received and sanctioned by government were for small works. The designs adopted for the masonry works and the data for all hydraulic calculations differed in each district. No uniform method was followed to attain the same result, a consequence of which was that a lot of indifferent work was carried out. To regulate this Mr. Allen, out of his irrigation experience obtained in his eleven years service in the Madras presidency, issued thirteen learned circulars among the district engineers and bound them down in the preparation of their plans of works to a uniform method and design. A great economy was thus effected on the initial cost of the works without affecting their efficiency and considerably reduced the subsequent cost of maintenance of those works constructed accordingly.

Several original works, mostly conception of Mr. Allen, costing over half a million rupees, were investigated during the third period and others put in hand. A description of these will form the subject of future articles in this magazine.

From what has preceded above it will be seen what immense good is done to the country by the advent of Mr. Allen as chief engineer in these dominions. Mr. Allen had always the interest of this country at his heart and strived to do the greatest good he could for it. He has now returned to the Madras service, but Hyderabad and its people will long remember him. The irrigation staff which was under him has been thoroughly organized by him, and each and every member of it has, under his able administration of five years, attained that professional excellence which will surely in future years continue to benefit the state.

THE PRIMER OF IRRIGATION.

Chapter XI.

LAYING OUT LAND FOR IRRIGATION.

If the author had his way about it, he would have the land on each side of every main or large supply ditch sloped down gently for at least one hundred and fifty feet, and on that slope he would plant peas, beans, corn, and melons and raise a good profitable crop without any or with very little furrow or surface irrigation. The seepage water would answer the purpose of sub-irrigation, or infiltration, as will be explained in another chapter. This water aided by deep cultivation and pulverization of the soil would be sufficient to gratify his most ardent hopes.

At the bottom of each slope would be established an open ditch or covered drainage system, and the surplus water caught and utilized for surface or furrow irrigation on the plat below. The land on the ditch slope would be plowed and cultivated parallel with the ditch line, and at right angles to it on the plat below the slope.

This system of laying out the land is equivalent to terracing but more convenient and natural, withal, less expensive, for the ditches can be arranged to suit the slopes of the land rather than the reverse. Should the land be sufficient in quantity to make it worth while and the topography permit, a series of slopes could be provided for and every drop of the usually wasted seepage water utilized. It is very pretty to the eye and looks very nice and regular on paper, but the author believes that although the ditches run everywhere in the most profuse irregularity and ugliness, destructive even of the refinement required of landscape art, yet there is nothing more beautiful to his eye than a luxuriant crop of profitable plants. Experiment and settled practice has demonstrated the utility and value of this system all over the world. Corn, beans, peas, peppers, onions, even small fruits and crawling berry vines growing to perfect maturity without a drop of water from the clouds or by artificial application, and as to the quality—well, they are imported into this country from Europe and the American epicure pays three times as much for them as for home productions because he finds them better suited to his palate. Every housewife knows that her window plants flourish and grow luxuriantly by keeping the "saucer" of the flower pot filled with water without any surface wetting at all.

The system is as old as Egypt and Babylon, and it is adapted to small farms and is an obviously economical system of increasing the duty of water without increasing its quantity, and it is more conducive to the perfection of plant growth and life than "over-dosing."

DITCH-BANK IRRIGATION.

The system last referred to is really what may be called "ditch-bank irrigation." The object of it, of course, is to use the water that seeps or percolates from the banks of a raised ditch, which is sufficient to moisten the slope of the bank and the soil for some distance outward from the base. We find that this system was in favor with the old Spanish settlers, who opened a ditch from a stream on a grade so slight that a very slow flow would result. The land on each side of this ditch was thus moistened and almost every variety of vegetables and small fruits were raised without other irrigation.

To accomplish the purpose, the land is deeply plowed, turning under a good covering of manure, then harrow thoroughly until the soil is evenly settled. After this the land is ready for the elevated ditch from which the seepage water is to be obtained. This is done by throwing back a few furrows to form a ridge which shall be high enough to command the land under it. The ridge is shaped evenly and the surface raked over, a hoe being used to mark out a narrow ditch. When the water is turned in the course of the water may be regulated with a hoe and by a little cutting and filling, so that the water will run evenly along the entire length of the ridge.

In less than a week the soil along the ridge will be in a suitable condition to receive whatever seed or plant it is desired to grow; indeed, there will be as much space along the base of the ridge as there is on its slope which will be sufficiently moist. If the ground is not too porous, the water will percolate slowly and evenly and moisten the soil without cropping out at the surface anywhere. By thrusting the hand into the soil it will be found that the percolating water is within an inch of the surface, but never quite reaches it, due probably to surface evaporation. As will be noticed in the case of sand, the surface may be dry but water-soaked an inch or so below.

The number of ridges may be multiplied to suit the quantity of surface it is desirable to irrigate in that fashion, and they may be made large enough to control a quarter or half an acre. Even though the land at the base is perfectly flat, the water flows down the slope and spreads out along the levels. Should the land be sloping generally, the overflow from the first or highest ditch may be troughed to a lower one and so on indefinitely. Wooden troughs of four-inch stuff nailed together in the form of a V, with two or three cross-cleets at the top to prevent warping, are very serviceable, and being about sixteen feet in length, comparatively light, and therefore easy to handle, may be made to reach any desired distance by overlapping. Or, the overflow from a series of these ridge ditches may be collected into one ditch and carried to small fruits or joined with a larger stream. The simplicity of the arrangement, though requiring some labor at first in establishing the proper grade, fairly compensates for that work and care, for during the rest of the season the irrigation is automatic, that is, it goes on uninterruptedly and without any assistance. All the repairs needed will be a few strokes of the hoe, a trifle of raking, and the land will always be ready for any kind of crop or succession of crops. Care should be taken not to puddle the bottom or sides of the ridge ditches, as in case of a reservoir. On the contrary the water should occasionally be shut off and the ditch raked up to open the soil, for the object of these ditches is not to store or hold water, but to enable the water to seep or leach out into the soil.

There is never any danger of the soil becoming soggy, for the quantity of water is small, regulated to suit the demands of the plants, and to allow for a slight evaporation.

DEPRESSED BEDS.

Growing out of the ditch-bank irrigation is the depressed or sunken bed system, which is quite similar, the water being fed from ridge ditches, but instead

of percolation the water is run directly over and upon the soil after the manner of flooding. The land is not sloped but is flat, or level, a small flow, however, being desirable rather than objectionable. It is adapted to very light and unretentive soils and for shallow rooting plants like strawberries.

The land is laid out in rectangular checks, or any other desired form, and around the sides of the checks are elevated ridges upon the top of which are laid ditches in which the water flows slowly and quietly. The water is admitted to the checks from several points at the same time and distributes itself over the surface uniformly, slowly soaking into the soil.

In the hot summer months when it is desirable to maintain the growth of shallow rooted plants, it is an admirable system, and is enhanced in its effects by spreading over the soil a mulch of rotten straw, or coarse manure under which, protected from the sun, the water slowly spreads with very little evaporation. It possesses more beneficial aspects than mulching and sprinkling, for the reason that the water is retarded by the presence of the mulch from reaching the roots of the plants, where it is needed, and evaporation is much more rapid.

For the hot, dry season, where there is no danger of over-saturating the soil, the depressed bed is available for all kinds of vegetables, small fruits and flowers, the use of it showing marvelous results.

The system is in common use in Europe, where the heat is not excessive, and where a light sandy soil is under cultivation. It is the system adopted by the market gardeners in the sand hills south of the city of San Francisco, where the vegetable gardeners have transformed large areas of apparently worthless land into terraces, and on these have arranged depressed beds in which enormous quantities of succulent vegetables are grown for the city market. The water is raised by windmills and pumps from wells sunk in low spots, and delivered to small flumes which run from the windmill towers to the opposite hillsides. The water is flowed upon the highest terrace and conveyed thence by means of troughs and small ridge ditches from terrace to terrace and all the beds filled.

In all cases of surface or ditch irrigation the land must be laid out to suit the flow of the water, which is necessarily down hill, so to speak. If the land is not smooth on a level or slope, it must be leveled or graded by means of a scraper or other device for removing uneven portions and hillocks. If the land is too uneven to be irrigated uniformly, then sub-irrigation is the only remedy, or piping water to the tops of the ridges, or by establishing a reservoir on the highest spot, and thence running ditches in every direction after tracing or laying out the courses with the leveler as related in another and previous chapter.

As much care must be taken proportionately in field culture as in the case of small kitchen gardens, the principle being the same.

To put land in shape to irrigate it should first be plowed as deep as possible and then cut into beds of a larger or smaller size, depending upon the quantity of land to be irrigated and the amount of water at the disposal of the farmer. This may be done by means of a drag constructed in the shape of the letter A, from eight to twelve feet and more at the bottom, running to a point at the top. The land is dragged by drawing the A-shaped contrivance point first across the field from side to side. The wide spreading ends of the drag gather in the loose earth, clods and other rough material and heap them up behind in the shape of a ridge. These beds may be made from sixteen to eighty feet wide and ten to forty rods long; it all depends upon the quantity of water at hand to fill them.

After the field has been laid off into beds, the ground between the ridges must be leveled if uneven or humpy, and for this purpose a scraper will be serviceable. By it the humps should be scraped into the low places, and then a harrow may be used and the leveling process finished with a board leveler, well weighted down. This is nothing more than a strong thick plank weighted with stones and dragged back and forth over the beds until they are in a perfect condition to receive water uniformly upon the surface. The ends of the beds should come up close to the main ditch, or to the large lateral ditch, so that the water can be turned on in full volume. These beds may be irrigated one after the other by flooding, or by furrow irrigation. Indeed, there is no limit to the manner of irrigating, the great desideratum being to spread the water uniformly over the entire bed. It will be perceived that the system is similar to that of the smaller depressed bed-irrigation, except that the ridge ditches are not used, the ridges around the large beds being used to retain the water and to mark out the land in such shape and sized plats as to correspond with the quantity of water on hand. The flow of water must be sufficient so that it will rapidly cover the bed, and if that is deficient then the beds must be made smaller, otherwise the plants at the upper end of the bed will flourish and produce well, whereas those at the lower end will be sickly and produce little if anything. This often happens in the case of corn, potatoes, etc., when the water runs either too rapidly or too slowly into the furrows. The slope of the land should be such as to provide a quick rush of water all along the line, and its standing in the furrows to slowly soak into the soil. For this purpose the source of the water supply must be considerably higher than the land to be irrigated, and the quantity delivered large enough to fill quickly. Too slow a flow and too small a quantity will soak the upper end of the bed and give the lower part too little.

One important thing to be guarded against in laying out the land for irrigation is to avoid the washing out of the soil by the action of the flowing water. Inasmuch as the land irrigated is always under cultivation and loosely put together after the action of the plow, it is very easily washed into gullies, and every gully means a lessening of fertility. There is not so much danger in this respect when the land is covered with a heavy crop and flooded, because then, the plants will retard the rush of water and prevent damage by washing. But in furrow irrigation, the furrow soon may become a deep gully which the plow and cultivator can not remove, and every subsequent application of water will enlarge. To obviate this it is good farming to make the furrows short by damming with a quantity of earth, and when one furrow—the first one—is well filled, remove the temporary dam and let the water flow down into another short furrow. This will be the opening up of a succession of reservoirs which, being small, will not be liable to cause any damage, and will permit a speedy watering of the entire row of plants.

BROUGHT BY THE POSTMAN.

Letters From Correspondents Who Want to Know Where They Can Obtain Many Things.

Chicago, Feb. 8, 1904.—To the Editor of The Irrigation Age: These are pre-eminently days of reform. Many of the reforms are in the wrong direction, as witness the development of municipal governments on the reformers' methods. Nearly all are based on the socialistic plan where the wastefulness of public management is substituted for the more careful and satisfactory methods of individualism. All radical changes are looked upon as reforms and he who stops to discuss the value of the conditions that we will arrive at under these methods as compared with that from which we started, is looked upon as a fossil and belonging to the Silurian period.

We have now arrived at that period when the land laws are to be swept away, excepting the original homestead act, shorn of its commutation clause. Private ownership of timber lands is to be shut out and the whole timber interests of the country are to be managed by a bureau at Washington. Lincoln has well said that "You can fool some of the people all of the time, and all the the people some of the time, but not all the people all of the time." It is beginning to look as though there is an exception to this rule which comes from applying the methods of misinterpretation and exaggeration. The public has been led to believe that the amount of frauds in the administration of these land laws has been so great and so destructive to the interests of the public that the repeal of the land laws has become a necessity, to save the remaining timber lands from being wasted and destroyed. And, in order to save some remnants for future generations and to apply proper forestry methods to the great timber reservations, an army of foresters and assistants must be placed in charge of the remaining timber to secure the application of right methods of forestry.

This is built upon the presumption that individuals who own the timber lands will not make as good use of the timber standing, will not have it cut as carefully or apply as good forestry methods in reproduction as will be done by this army of Government employees. This presumption is based upon a misunderstanding of human nature and the methods of competitive business life. Let our legislators look over the methods employed by the Government in the past twenty years in supervising the lumber on the reservations in Minnesota, and trace out in detail the amount of value derived by the public from these reserves in comparison to that which has come from lands held by private owners and then consider the application of this method of public ownership and administration as compared with private, of the timber lands of the Coast states, where the great timber areas will be for a perpetual forest supply and particularly apply this to the scattered pieces of land that could be taken up under the timber and stone act and the exchange clause of the forest reserve act or the commutation clause of the homestead act, and see how immensely more wasteful the public methods will be as against the more careful ones of private ownership, into whose hands these lands would fall through the agency of the citizens' locations under these acts.

When these scattered pieces and tracts of land are perpetually held away from location and taxation and the great forest reservations are taken out of the reach of the lumbermens' operations, not only will there be extra high prices on lumber, but the timber will be wasted in miscellaneous frontier denuding processes, mostly carried on by individuals or by the agency of fire. Will the forestry department or members of Congress claim that these scattered pieces, tracts and portions of timber land that lie outside of the forest reservations will be more useful to the people of this country where the individual is interested in taking care of it, making the best use of the timber, so as to get the most out of the land as against placing it in the public hands where the timber is so scattering that it will be absolutely impossible to look after it without expending more money than the Government will ever be able to get out of the land or timber. It is very difficult for individuals who own scattered tracts of land to prevent waste and destruction and still more so on the part of Government officials, who only travel through the country occasionally, even though there be large numbers of them in the field.

The basis of all this is the great frauds that have been committed mostly under the timber and stone act. Persons who are more familiar with the frontier land business and who have been concerned in it for years are apprised of the fact that not five per cent of the frauds that have been claimed have been committed. Not only no such wholesale frauds that have been so broad, persistently repeated, but only a small fraction of the amount claimed. And after repeated and repeated and repeated statements of great wholesale frauds that are just being unearthed, and without any results ever showing up excepting an isolated case here and there it would seem to be time that we cease to legislate on such special pleas that have been made with entirely insufficient basis to rest upon. There are other reasons, and political ones, why the opposition would be glad to have the Republicans repeal these laws before the next election. The loss of Washington, Oregon and California may make the turning point in the Presidential and Congressional majorities.

H. B. Webster.

Spokane, Wash., Feb. 12.—Editor The Irrigation Age: I own some land over in Montana which must be irrigated by pumping. I am anxious to learn what is being done elsewhere in this particular line. I find nothing in the Government publications which is of any particular value. Most other reports I have seen are so general in the statements given that my purpose is not served. I am anxious, therefore, to get the facts in detail about a few pumping plants where water is lifted over fifty feet in height. I want such facts as will cover capacity of pump, where manufactured, character of pumps, number of cubic feet of water for twenty-four hours, size of pipes, height water is lifted, number of acres covered, cost of fuel, cost of labor, cost of plant, and such other facts in detail as a man on the ground naturally would seek.

Anything you can do for me will be appreciated. I remain, Very respectfully yours,

Chas. C. Reeder.

St. Anthony Park, Minn., Feb. 6.—Editor Irrigation Age: Will you please have sent me by return mail the addresses of all the drain tile manufacturers you know in Minnesota, Wisconsin, Iowa and Illinois, and greatly oblige.

Very truly yours, W. M. Hays.

St. George's Indian School, Lytton, B. C., Feb. 4.—Editor The Irrigation Age: Recently I wrote to the P. & O. Company, stating that the implements used here for marking out irrigation lines seemed very primitive and asking whether they had any machine for that purpose. They replied that they had not and advised me to write to the Irrigation Age. Could you please send me a sample copy and if you have an old number with an illustration of such an implement required I shall be much obliged to you.

Yours truly, Geo. Ditcham.

Oakville, Tex., Feb. 13.—Editor Irrigation Age: Mr. James Duffy, of San Antonio, sent me your letter of December 4 to him, in which you said that for $10.00 you would send a very nice selection of books on irrigation and drainage, and in which you say that you included in that list F. H. Newell's work on irrigation at $2, so I take it that for $8 you would send the collection suggested, and I herewith hand you check for $8 on Frost's National Bank, San Antonio, for which send me the selection omitting Newell's work on irrigation which I have.

I own a 60,000-acre ranch through which the Nueces River runs and I am just commencing to irrigate it on the river and I desire all the information I can get on the methods of transmitting water most economically, which at present I am arranging to pump from the Nueces River on black sandy loam which will eat up a great deal of water, hence my desire to economize the use of water as much as possible.

Now that you understand my situation and inexperience if in addition to the list you intended for Mr. Duffy you know of any other books or magazines which will aid me, you will please send them along, provided, of course, that you make the lowest rate obtainable on those publications and on receipt of same with bill I will remit you any balance that may be due.

Thanking you in advance for your prompt kindness I beg to remain. Very truly yours, C. F. Simmons.

IRRIGATION PROBLEMS IN KANSAS.

Fertility to Be Solved by Moisture Retaining, Soil Cultivation and New Adaptations of Tree Life.

[From an address delivered by Congressman Victor Murdock before the Western Kansas Irrigation Association.]

Since last spring I have devoted a major portion of my time to a study of the question of irrigation. The greatest barrier in the way of western Kansas in this matter is a widespread disbelief, outside western Kansas, that irrigation in western Kansas is practical, a disbelief that reaches the departments here in Washington as a distinct denial of the feasibility of all plans so far proposed. I will recite presently some of these denials, greatly disheartening as some of them may be, but before I do, I want to say this to the western Kansans: The true pioneer never played a craven before a hard problem. The nation builder, wherever he is, has been always a man who dared face complex and difficult propositions. The difficulty in front of him always contained an invitation, it beckoned him while it defied him. From the day that the Pilgrims landed on a grim and forbidding coast, this has been true. It was true of the men who plunged westward in the wilds of Ohio, who faced the swamp problems of Indiana with their train of death-dealing fevers, true of the men who pushed beyond the Mississippi and made settlement alone among hostile and treacherous savages. The western Kansan has no problem of disease to face —his is the healthiest climate on earth—there are no hostile savages near, but before and about him stretches a vast plain, uniformly inviting, without stump or rock or mountainous tracts, with bordering wash-plains of coarse debris bare of soil—to be deducted from the total, a great prairie of unsurpassed soil strength with a flood of God's sunshine to invigorate it—but with a single problem presented—that a physical problem—the occasional recurrence of groups of years of insufficient rainfall. He will, with patience, and fortitude, solve the problem—with new methods of moisture-retaining, soil cultivation, with new adaptations of tree and plant life, and with irrigation applied in the years of insufficient rainfall. And it will be well to remember that irrigation in this country is yet in its boyhood.

In 1890 the area, in this country, irrigated, totaled 4,000,000 acres. In 1900 it was 7,300,000 acres. The total area of the arid regions in this country is 800,000,000 acres. Of this area it is estimated that not quite one-half is cultivated—that is, if irrigation were not necessary, so much could be farmed with profit—but it is estimated also that from all sources there is water available for more than 60,000,000 acres. In other words not more than 7 per cent is reclaimable, and the actually irrigated area of which we hear so much is less than 1 per cent of the whole.

Western Kansas is not in the arid region and is not so placed by the scientists. It is designated as sub-humid, with an acknowledgment that it is a portion of the time humid. Since 1874 the Government has kept a record of precipitation at Dodge. The normal annual rainfall there is 20.38 inches. In 1875 it was nine inches below this; in 1876 four inches below; in 1877 seven inches below; in 1878 two inches below; in 1879 four inches below; in 1880 two inches below; in 1881 thirteen inches below; in 1882 seven inches below; in 1882 eight inches above; in 1884 nine inches above; in 1885 three inches above; in 1886 one inch below.

It was this group of years of great rainfall, from 1881 to 1887, which brought on the great boom, it will be remembered. Since that period there have been other periods above the normal. It was in 1891 eleven inches above the normal and eleven inches above again in 1898.

In the light of this condition of occasionally perfect wheat-growing conditions, and the fact that irrigation wherever applied is confined to restricted and intensive farming, and all western Kansas is productive during years of sufficient rainfall, irrigation in Kansas will be supplementary. To the west of Kansas the agriculturist has no help from nature at all—he looks upon rainfall as practically negligible—he must depend upon irrigation entirely.

Here I come to the first obstacle in the way of interesting the Government in irrigation in western Kansas.

The Government contends that whereas the agriculturist in the arid region must either irrigate or move out, there are so many years of sufficient rainfall in western Kansas that the agriculturist there can and does get along without it, and his interest in the subject wanes, and necessity does not drive him, as it does the farmers in the arid regions, to adopt means—a position, of course, not wholly well taken, but assisting in benumbing government interest in our case.

Now, in the matter of water supply, some of the hydrographers insist that the catchment area of the eastern slope of the Rocky Mountains is not sufficient to irrigate the arid regions at the foot of the mountains, to say nothing of the prairies of western Kansas, and point out the frequent trouble in the arid regions where the man of later settlement suffers while the man with a prior water right is supplied, in case of interminable ill feeling. But we all see floods of water waste seaward, in the Arkansas, every spring. Could that water be stored? The objection is made here that, because of the silt, the life of the reservoirs would be too short. I think that objection, and I think you will agree with me, is far-fetched, not well founded. Now the geological survey says it has not been able to find in that part of western Kansas topographically surveyed a reservoir site of any considerable area which could be reached by a division of the flood waters and have beneath it lands of an irrigable position. The bureau wants the topographical survey of Kansas, on which little has been done since the days of Plumb and Ingalls, completed, and, in the hope that a complete survey will reveal, to the geological survey's satisfaction, reservoir sites, I will work to have it completed.

As you know, the geological survey is working under the reclamation act. This act provides that a suitable reservoir having been found, or profitable diversion of water, or other irrigation enterprise, the Secretary of the Interior shall withdraw from public entry all irrigable lands beneath such work, shall upon the completion of such work sell these lands at increased price to reimburse the Government for the cost of construction of such work, the work to pass ultimately to an association of the irrigators. As Kansas has little public lands many of us, at our meeting at Garden City last spring, thought we did not come under the reclamation act. But it is now believed that the act will be so construed that private lands under an irrigation work can be given as security to the Gov-

ernment for the cost of construction, and the same result reached. Arizona, in some sections, is in the same condition as Kansas in the matter of the lack of public lands, and is working for this construction of the act.

In the matter of the right of the water of the Arkansas river, the authorities are inclined to believe that this stream owes a first duty to the lands that it traverses first; that there is an economy in applying its waters to the lands at the foot of the mountains without loss from evaporation or seepage. But the question is, as you all know, now in the Supreme Court.

There is no positive information at hand of the volume and supply of the underflow of the Arkansas. I have presented the plan of a siphon or pipe line carried eastward to an outlet, down the general incline, and have asked a written reply to the assertion of its practical practicability, but regret that the reply has not come that I might transmit it to you.

The irrigation of tracts upon the inter-stream areas in western Kansas—those tracts far off the river—caused me to look into the matter of our "sheet water." The hydrographers hold that much of this water has its origin in the mountains, but it is a small portion of the precipitation in the mountains. In support of this they point out that erosion in the mountain catchment area has in the main exposed granite cores, that the great body of the water that falls runs off into the streams, and that the area of actual intake for underground drainage toward Kansas is relatively very small, consisting in, along the mountain flanks, of the porus rock sheets which, far to the east, constitute the deeply buried water carriers. They hold that this deep water would, if it could be profitably pumped from a great depth for irrigation, soon be exhausted, a proposition I do not believe and I do not think myself they can demonstrate. The vast accumulation of deep water under western Kansas, if it could be raised economically for irrigation, would be found sufficient for all purposes. And I believe that some day it will be raised by improved engineering appliances.

This brings us to the question of artesian wells. The scientists claim that artesian water found in some parts of western Kansas is caused by impervious shales pressing down this water from above; that when this impervious shale is punctured the shale-imprisoned water rises to its level to the west, and if the surface of the earth above the puncture is below underground water level in the west, the water gushes forth above the earth, as it does in Crooked Creek Valley in Meade County. The department will not sink deep wells for artesian demonstration where deep wells exist or are being bored by private individuals.

There are three bureaus here which I am seeking to interest in our problems, the geological survey, which is in the Department of the Interior and which I have previously dealt with in this letter.

The second bureau is the one on irrigation experiments, which is in the Department of Agriculture. This bureau has in charge the demonstration of the economical supply and use of water for irrigation and can, and I believe will, assist us.

The third bureau is the bureau of forestry, in the Department of Agriculture, but the administration of which is in the Department of the Interior. This bureau investigates trees and tree methods and designates forest reservations. Having designated a reservation it lies with the Department of the Interior to withdraw the public lands so designated from entry. Several months ago the bureau designated a forest reserve to the south of Garden City. The Department of the Interior now has the matter under advisement and is inclined to rule (but it has not and it is vital to us must not) that the law can not be construed to permit the designation of a forest reserve on a tract having no trees. The matter is further complicated by the inclusion in the designated reserve of considerable private land. In the hope of a favorable decision I have asked the bureau of forestry to furnish me data of public lands in western Kansas where other forest reserves might be created if any considerable tract exists. I know we have much to expect from the tree in western Kansas.

IN THE RIO GRANDE VALLEY.

Possible to Irrigate by Pumping Thirty to Forty Cents Per Acre.

MESILLA PARK, N. M., Feb. 29.—To the Editor of THE IRRIGATION AGE.—In a bulletin issued by this station some time ago it was shown that the work that we had done up to that time showed that it was possible to irrigate from wells at an expense of from fifty to sixty cents an acre for a three-inch irrigation. This was on short runs with different pumps and under conditions not as economical as are to be found on the average farm. Since this bulletin was published our work has been carried further along the line of seeking to reduce the cost of pumping from wells, with the result that by using a crude oil engine the cost is cut almost in half, as represented by the above figures and an acre can be irrigated three inches deep and at an expense of thirty to forty cents. The most favorable conditions in other parts of the United States where irrigation is practiced from pumping show nothing as favorable as these figures.

You ask me for my opinion of the present value of land in this valley and the possibilities that may be realized by irrigation. I would state that in a general way the land in this valley, not in cultivation is worth from $10 to $25 an acre. This represents uncultivated land which would have to be, of course, improved before it could be put in cultivation. Cultivated land in alfalfa and other crops may be bought at present at a price of $25 to $100 an acre, depending largely upon its location.

As for the possibilities for this valley, I believe, speaking conservatively, they are unequaled in the United States. I make this statement in view of the fact that we have carried on for the past year or two a careful comparison of the conditions as they exist today in this valley with some of the most favored regions of Colorado, California and other States. It is possible to make an income from the land in this valley far in excess of what can be done under the average conditions in other States. We have the most fertile soil, an apparently inexhaustible underflow supply of water, and a river running through the length of this valley whose waters show by analyses covering a period of a whole year as taken at this experiment station, that they deposit on each acre of land irrigated from the river, fertilizing material to the value of $29 per acre per annum. This means that the fertility of our land may be maintained indefinitely. In addition to this we have an almost ideal climate and possibilities for good markets.

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MAN WITH THE SHOVEL.

Versus the Man with the Book—How Science Can Be Applied Successfully.

By B. P. F. in Ranchman's Reminder.

The man with the shovel (with apologies to Markham) is very properly the man who wades about in the irrigated field directing the playful irrigating stream here and there, while at the same time providing for the ubiquitous mosquito a feast nicely parboiled by the glaring sun of Western midsummer. This man, like anyone engaged in the acutal practice of a pursuit, is often inclined, and sometimes wisely, to view with mingled amusement and contempt the scientific abstractions and vaporings of the student. He feels confident that this man of learning would find but little application for his so-called science in actual work, and would feel his boasted enthusiasm for the dignity and nobility of the profession slowly running out of the holes in his leaky boots when actually face to face with the dreary proposition of spreading a "two-inch stream" over a half section of "knolly" land. Yet, however true this may be, there really is a science as well as an art of irrigation.

To irrigate is not merely to divert water from the stream, convey it by ditch to the land to be watered and there turn it loose. From the legal act of appropriation to the physical act of watering the land, legal and technical knowledge, combined with good common sense, is constantly necessary. In order to acquire a right to water, a man should be conversant with the legal requirements with which he must comply before the right will be granted him. In the construction of his ditch he should know something about the capacities of ditches of different sizes and grades, in order that the costly mistake will not be made of building a ditch too large or too small for the area of land to be irrigated. After the ditch is in use a man should know at least the more simple and approximate ways of measuring water, in order to protect himself against the "water greed" of his neighbors.

Finally, in applying the water to the land a knowledge of the moisture requirement of the crop as influenced by the physical and chemical condition of the soil, the climate, surface and sub-surface drainage. etc., will aid materially, not only in the economical use of water, but also will result in increased crops.

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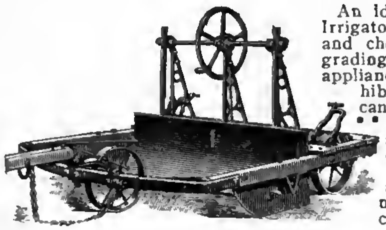

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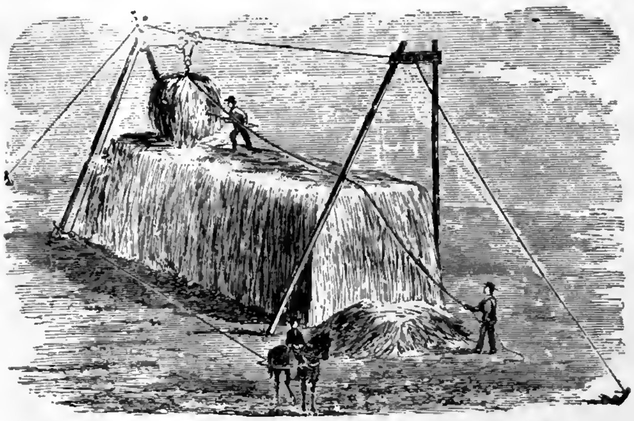

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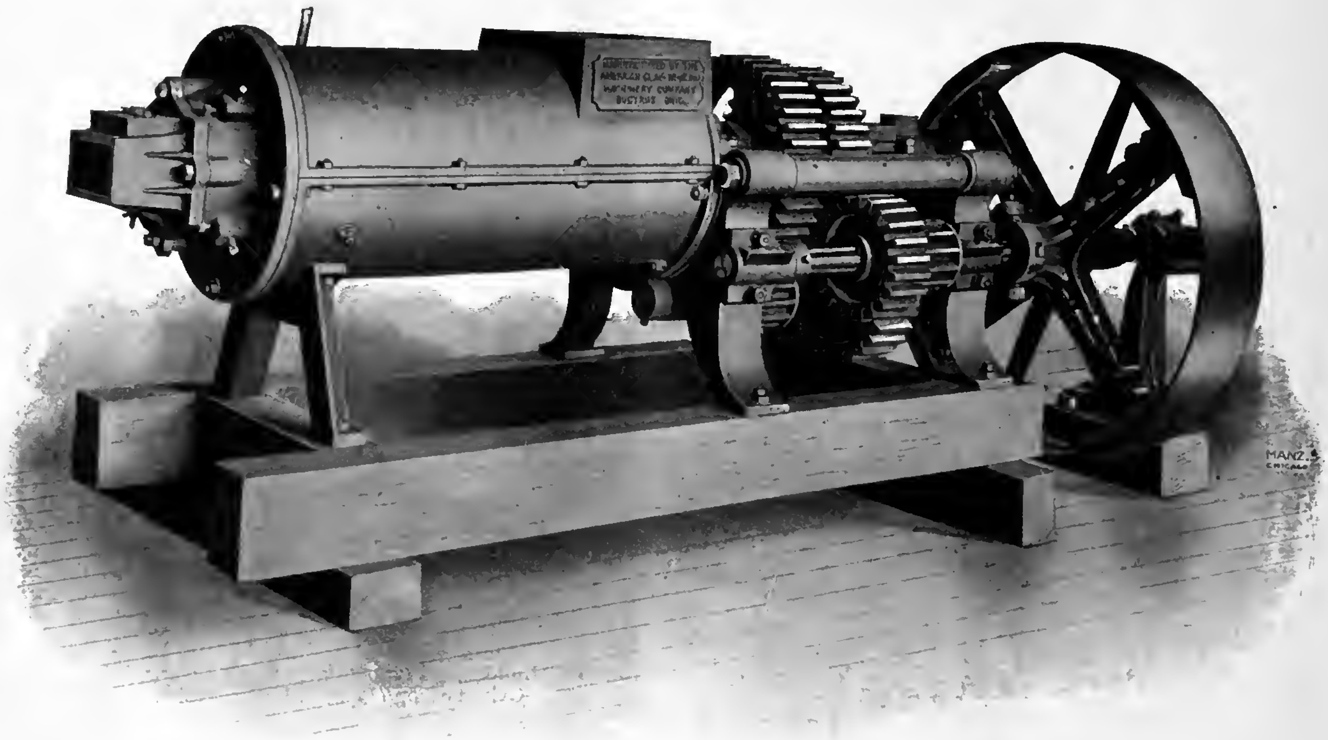

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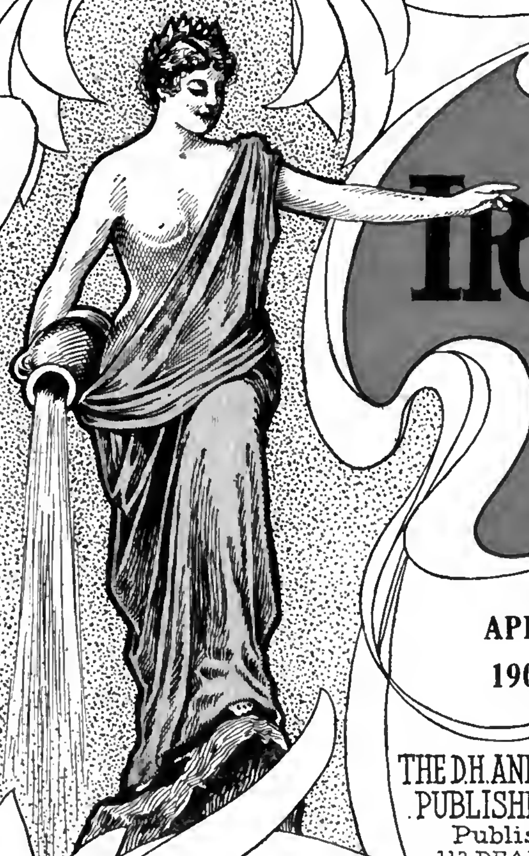

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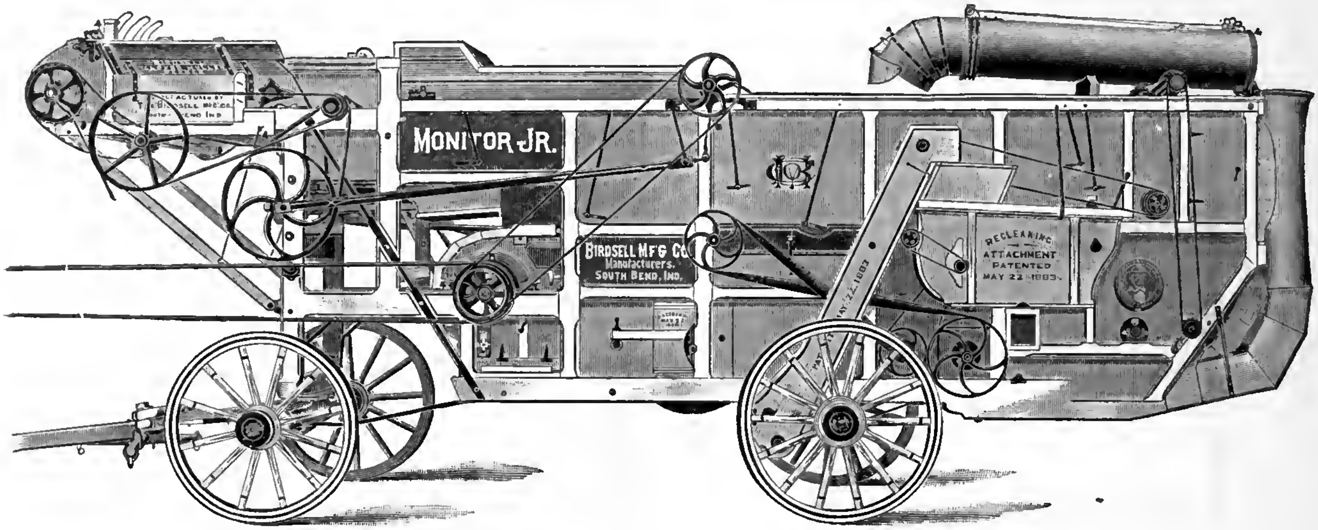

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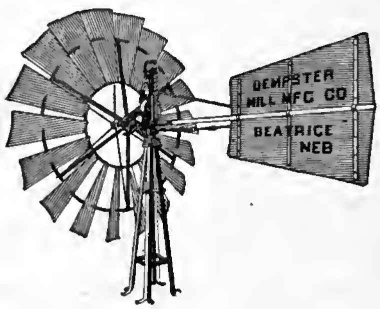

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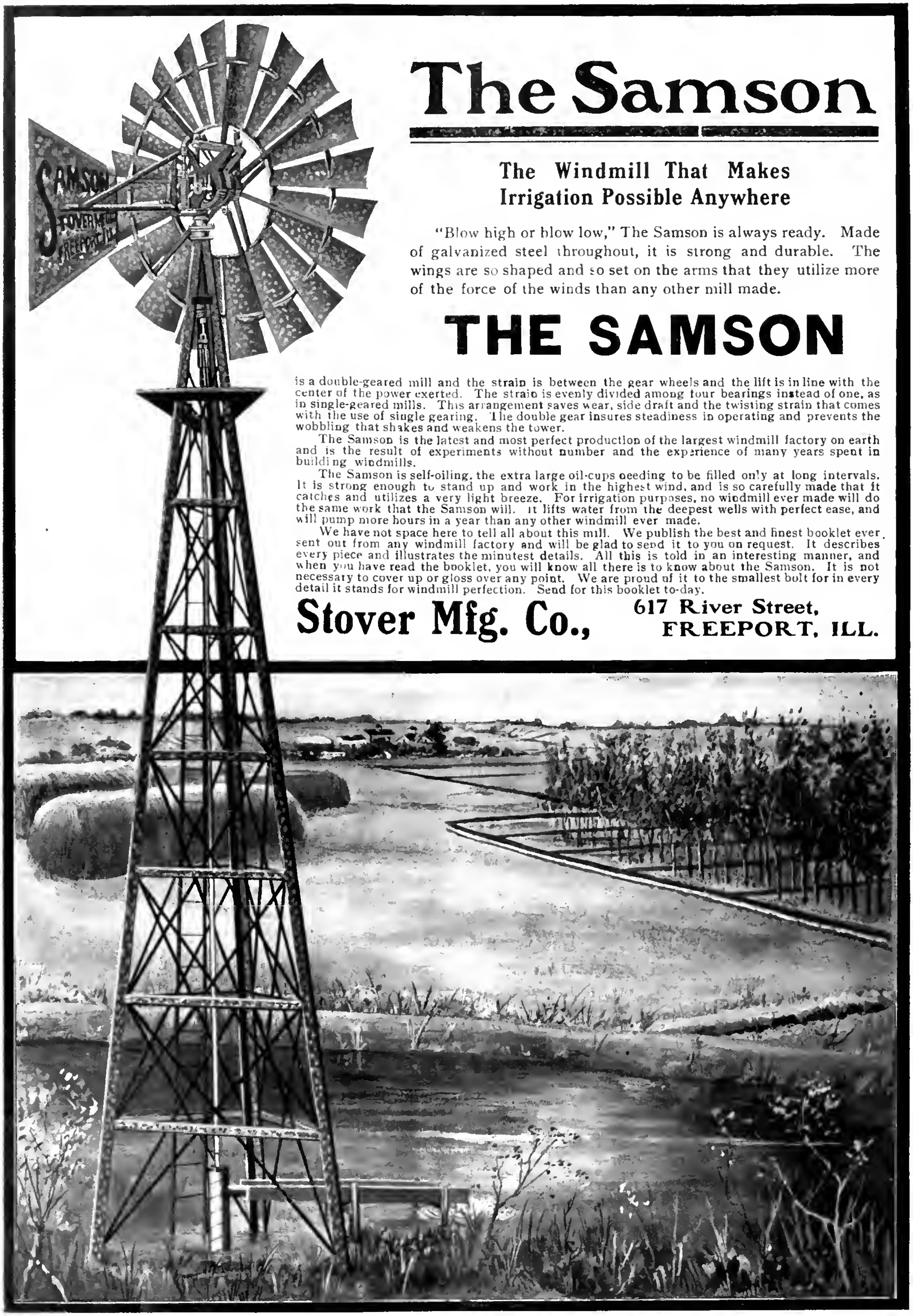
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EDITORIAL

Notice to the Public. Mr. W. J. R. Johnston is not connected with THE IRRIGATION AGE or with the D. H. Anderson Publishing Company in any capacity. He is not authorized to make contracts for advertising or to receive subscriptions, collect money or receipt for the same. THE IRRIGATION AGE employs no canvassers or solicitors who do not carry proper credentials from this office signed by D. H. Anderson, president of the D. H. Anderson Publishing Company.

A Little in Advance. An esteemed subscriber writing from Nevada to continue his long connection with THE IRRIGATION AGE for another year, says the practical courses outlined by this paper regarding drainage in agricultural as well as horticulture are on the right lines, but perhaps a little in advance of some communities. It is always the duty of a journal to lead thought in public improvements of all kinds, and while we may be slightly in advance of the drainage procession, it is coming along with such a mighty rush that it is hard work to keep out of the way. People are becoming educated more rapidly than ever before to the immense benefits of drainage and irrigation and the paper that does not take advance ground today may find itself obscured by the dust of the progressive thought of the people that sweeps by it tomorrow.

Openly Charged. Senator Hansbrough charged openly in the Senate last week that the movement to secure the repeal of the present land laws, particularly the commutation clause of the Homestead Act, was due to the efforts of a powerful lobby composed mainly of holders of lands bought in large tracts from the railroad companies. If these lobbyists could succeed in having the commutation clause repealed, intending settlers would be forced to buy their lands from these big corporations and the value of these holdings would be largely increased. This is precicesly what THE IRRIGATION AGE has tried to make plain to the people for a long time. It is surprising that any sensible man should be fooled by the hypocritical plea put up by the Octopus that it is purely unselfish in its motives and is working in the interests of the settler of future generations.

During the discussion over the proposed repeal of the land laws in the Senate, one of the Senators stated that a great syndicate that had recently bought from a Western railroad a very large body of land at 70 cents per acre had its lobbyists swarming through the corridors of the capitol working for the repeal of the commutation clause of the Homestead Act. He further stated that the managers of that syndicate are now in Washington conferring with Government officials and

using every power in their means to accomplish this end. The mask is being stripped from the hypocrites who pretend to be unselfish in their motives in urging the repeal of the Homestead clause and their utter selfishness and cupidity is plainly exposed.

Since THE IRRIGATION AGE called attention to the sacreligious hypocrisy of the land-grabbing Octopus in hoisting the sacred cross as its emblem of battle, the managers of that unholy combination have become alarmed and forced the editor of its principal publication to remove the picture of the cross from its title page. The spectacle of this gang of land-grabbers who are trying to force Congress to pass laws to aid them to rob the poor settler hoisting the sacred cross was not only impudent but blasphemous in the extreme.

Commutation Clause Will Stand. President Roosevelt's special land commission in its preliminary statement says: "Much evidence has been submitted tending to show that in the prairie States, where it has been most used, the commutation clause of the Homestead Act has been of advantage to the settler without serious loss to the Government." This paragraph in the report evidently escaped the observation of the censor of the land-grabbing Octopus, because the hired man of that enemy of the public good has persistently declared through his subsidized papers and in public speeches and letters that the commutation clause was doing untold injury to the Government interests and that it was of no benefit to the settler.

Another clause which the censor evidently skipped in editing the report is: "On the contrary the Government has been peculiarly benefited by it (the commutation clause), because under this act the land is paid for in cash after fourteen months' residence, while without commutation the entryman will receive a patent after five years' residence without paying for the land."

This statement is in direct opposition to the claims made by the hired man of the Octopus and his traveling agents. They have constantly waged a bitter war upon the commutation clause of the Homestead Act because, as they asserted, it has been of no practical benefit to the actual settler, but simply provided a convenient avenue of robbery by speculators. As there is no doubt that the report of the commission was known to the managers of the Octopus before it was submitted, their acquiescence in its statements is another evidence of its ingenuity in adapting its plans to meet emergencies. The Octopus fought the National irrigation law with all the bitterness and vindictive fierceness that characterize a religious war up to the very moment that it became a law. When, however, it discovered that it was unable to defeat the measure, it suddenly changed its tactics, proclaimed it had been instrumental in securing the passage of the bill and has ever since brazenly stood before the public as its godfather.

Upon What Evidence. The public lands commission appointed by President Roosevelt to investigate the existing land laws and make recommendations has filed its preliminary report. This commission consists of Land Commissioner W. A. Richards, Chief Engineer F. H. Newell, of the geological survey, and Chief Forester Gifford Pinchot. These gentlemen made a three weeks' trip, including the time traveling from Washington to the Pacific coast and back, one week of which was spent in attending the National Live Stock Association meeting at Portland. With the exception of the time spent at Portland, the committee were riding in sleeping cars most of the time. Their preliminary report comprises less than two thousand words, including quotations from the land laws, supreme court decisions and other documents.

The committee presents no record of facts obtained during its so-called investigations, but proceeds to make recommendations of great scope and affecting immense areas of public lands and which, if adopted, will have tremendous influence upon hundreds of thousands of settlers. From the character of the report, it is evident that the committee has not based its recommendations upon any real facts secured by it during its rapid flight across the continent and back again, but followed the advice of the managers of the land-grabbing Octopus and made its recommendations to fit public sentiment. The managers of the Octopus have discovered that there is no possible hope of repealing the commutation clause of the Homestead Act and has given orders to its henchmen everywhere to trim their sails accordingly.

Two members of the public land commission, Messrs. Newell and Pinchot, have always maintained the closest possible relations to the managers of the Octopus and their preliminary report discloses very clearly the influences behind them. It is no doubt a bitter pill to swallow—this recommendation to let the commutation clause of the Homestead Act stand and modify the Forest Reserve and Timber and Stone Act in the interest of actual settlers—but the managers of the Octopus are a shrewd lot and know when to blow hot and blow cold. There is no doubt that the fight on the commutation clause will be renewed in the next Congress with great vigor, because the Octopus is out for big game, and with this law in the way they will not be able to force settlers to buy the lands which they have obtained from the railroads and the Government. Friends of the measure should not make this mistake of assuming that because the managers of the Octopus have temporarily stopped their fight upon it, they have abandoned it for good. They are simply bending before the storm of public opinion, but will quickly reassert themselves and continue the fight next year with greater arrogance and intolerance than ever.

Repealers are Defeated. The bitter fight that has extended over the past two years in the effort to repeal all the general land laws of the country has been practically ended by the Senate committee on public lands. This agreement resulted in the introduction of a bill by the committee, which does not affect the commutation clause of the homestead act, but which affects the stone and timber and desert land acts. Amendments prohibit the selection of timber lands in lieu of forest reserves, except that to allow owners of forest lands which have not been denuded of timber to exchange them for other vacant, unsurveyed lands without mineral or timber, subject to homestead entry. The amendment is a wise one and will prevent the land-grabbing Octopus from continuing its practice of taking up valuable timber land through agents, cutting off the timber and then exchanging the valueless land for other valuable agricultural lands. Persons who have holdings in forest reserves and have not denuded them of the timber are protected in their rights.

The fight in the Senate committee over this matter was the most bitter that has characterized the work of Congress during the present session. Senator Quarles was the father of the original bill, which provided for the repeal of the timber and stone act and the desert land act and the commutation clause of the homestead act. The last meetings of the committee to consider this bill were marked by discussions which became strongly personal in one or two instances. At the outset all of the Democratic members of the committee, except Senator Dubois, and three Republican members, Senators Bard, Nelson and Dietrich, were in favor of the Quarles bill, which was backed by the Octopus, but Senator Hansborough sturdily refused to report the bill without having a chance to be heard in opposition to it. On two occasions he forced the committee to adjourn without action.

In the meantime the true friends of irrigation rallied for a final defense of the rights of the common people as against the land-grabbing Octopus, and Senator Nelson was won over from the opposition. Senator Quarles finally agreed to drop the fight on the commutation clause.

The greatest victory next to the saving of the commutation clause is the provision which requires the secretary of the interior to turn the money acquired from such sales into the reclamation fund for irrigation purposes. The Octopus has been making its fight to repeal the general land laws for the express purpose of depriving the reclamation service of the use of any further funds. The success of the reclamation measure depends entirely upon the funds to be obtained from the sale of Government lands. If the Octopus could have succeeded in taking these lands out of the market the supply of money from this source would have been stopped and the general irrigation movement would have become a failure. The provision, however, to turn all money from the sale of timber into the reclamation fund will enable the Government to carry out its plans of irrigation, and the service will not be hampered for lack of money.

The fight upon the general land laws, and particularly upon the commutation clause of the homestead act, has been backed by the most powerful interests of this country. Money has been spent without stint, newspapers have been subsidized, speakers have been hired to travel over the country and address boards of trade, labor organizations and any public meeting that would listen to them, and Congress has been besieged by an army of salaried lobbyists, more insolent and aggressive than has ever been launched against any measure in Congress during recent years. The fact that the true friends of irrigation have been able to defeat this mighty combination of corporate interests, whose aims were purely selfish, is a matter of congratulation to the entire country.

The Age Pays Advertisers. While on a recent trip through Ohio, a representative of The Age talked with a manufacturer, who informed him that they had sold machinery to one firm in Australia, as a result of advertising in The Irrigation Age, to the amount of $2,800. This order the purchaser stated resulted from seeing the advertisement of the firm in the columns of The Irrigation Age, and is only a starter which will no doubt lead up to large sales in the future. The firm making the sale has paid us about $200 per year for their advertising and have expended in all not to exceed $300 for space in the columns of this journal. Assuming that a profit of 30 per cent is made on the goods and that no more sales are made as a result of the advertising already carried, it can be seen that a handsome marginal profit is still allowed the manufacturer. Another view of the case, however, is that this order may lead to many more from the same Australian house, which will no doubt develop a fine trade for the goods in that far away country.

Our conclusion is that advertising in The Irrigation Age has paid this firm well and we are publishing these facts in order to attract the attention of the large number of other manufacturers who may get some of this business by patronizing these columns. Why not write us for rates and, if you are not posted, learn definitely about our circulation.

Water Rights in Colorado. Many years ago some far-seeing gentleman practically captured all of the Arkansas River and its tributaries through Colorado and much of it down through Kansas as well. Twenty years ago water rights in the arid West were not regarded as highly as they are now.

With the growth of population in all parts of the State and the possibilities of irrigation becoming more apparent every year, the value of water rights have increased to proportions that were almost undreamed of. Land values are in a large measure affected by the water supply and particularly in Colorado.

The Arkansas River drainage basin in that State comprises nearly 20,000,000 acres and more than 70 per cent of this area depends upon irrigation for its crops. The available water supply is not sufficient at all seasons of the year and when the scarcity prevails the value of certain rights over others becomes apparent. People who contemplate settling in Colorado can not as a rule secure a water supply from the public any longer. The rights to most of the water in that State are now controlled by private individuals or companies and the intending settler must get his water from them. These rights are called "secondary rights," since they are not derived directly from the public, but from companies, who have in years past acquired control of the Arkansas River and its tributaries.

The loose methods which have prevailed in the acquirement of these rights in the early settlement of the State and the lack of uniformity in the franchises and contracts acquired has caused a great deal of trouble and litigation, and the courts are now attempting to straighten out the tangle and decide the rights of the settler as well as those of the irrigation companies. The value of these rights are governed largely by physical conditions and the nature of primary rights. Under the Colorado laws a river and its tributaries are considered as a whole in regard to water rights. The right to take water from any part of the stream is always subject to prior rights to take it from any other part of the stream or its tributaries, except when certain physical conditions exist. The laws of Colorado also make water personal property and give to appropriators practically private ownership. The influence of such ownership and the contracts which they hold with the State are of vital importance to settlers.

This whole question is very ably discussed by the Hon. J. S. Green, ex-State engineer of Colorado, and the result of his investigations extending over a long period has been issued by the United States office of experiment stations in a special bulletin. This bulletin is No. 140 and its title is "The Acquirement of Water Rights in Colorado and the Arkansas River Valley." It is a work of great value to farmers and other users of water, as well as to intending settlers, and should be read by everybody who is interested in the vital subject of water supply in the State of Colorado. Free copies of this bulletin can be had by application to A. C. True, Director of the Office of Experiment Stations, Washington, D. C.

Peculiar Use of the Mails. The agents of the Octopus are flooding the country with extracts from speeches of Senators in favor of repealing the land laws. These extracts are sent out under the franks of certain congressmen and the Government is compelled to pay thousands of dollars for the transmission of these documents through the mails. The improper use of these franks is shown by the fact that the matter is sent out from Washington by the hired agents of the Octopus.

So brazen is the work of these agents that they do not hesitate to use any means to accomplish their end. The fact that these documents are being sent out from the office of the *Homemaker*, the organ which is supported entirely by the money of the Octopus, is shown by the mailing directions placed upon them. The post-office mailing list of the *Homemaker* and the printed names of the persons to whom this paper is sent is placed upon the documents carrying congressional franks.

These documents do not contain full discussions on the land law repeal bill, but only such extracts from the speeches of Senators as are favoring the repeal. No attempt is made to give a fair presentation of the facts as brought out in the discussions, but the campaign is wholly one-sided. The franks of certain congressmen are used without limitation for this purpose.

The exposure of this disgraceful misuse of franking privilege ought to be sufficient to condemn it forever and cause a repeal of the act which makes it possible for selfish corporations to rob the Government in this way. No congressman has the right to use his frank for such a purpose, and it is surprising that any self-respecting congressman would permit himself to be used in this manner by the Octopus and its agents.

The Irrigation Age, through the courtesy of the Department of Agriculture, is enabled to present the result of the investigation of drainage of farm lands by C. G. Elliott, Government expert in drainage and irrigation, together with the illustrations used in his bulletin No. 187. This bulletin is of great importance, as it contains a vast amount of information of practical value to small farmers who desire to reclaim swampy lands and bring them to a high state of cultivation.

"What do we plant when we plant the tree?
We plant the ship which will cross the sea;
We plant the mast to carry the sails;
We plant the plank to withstand the gales;
The keel, the keelson, the beam, the knee;
We plant the ship when we plant the tree.

"What do we plant when we plant the tree?
A thousand things that we daily see;
We plant the spire that out-towers the crag;
We plant the staff for our country's flag;
We plant the shade from the hot sun free—
We plant all these when we plant the tree."

NAILED MAXWELL TO THE CROSS.

Forced to Admit Before the House Committee on Arid Lands That Big Corporations Give Him Over $60,000 Per Year—No Repeal of Land Laws This Session of Congress.

George H. Maxwell, the manager of the land-grabbing Octopus in its fight for the repeal of the land laws, was a witness in the hearing before the House Committee on Irrigation of Arid Land April 1st. In this hearing Maxwell was forced, in spite of all attempts to evade the questions put to him by Chairman Frank W. Mondell, the truth of every charge that THE IRRIGATION AGE has made, namely: That the National Irrigation Association (not the National Irrigation Congress) has been supported and controlled by the great interests that are working for the repeal of the land laws; that Maxwell had received and is now receiving about $60,000 per annum; that he is the whole thing; that he gets all the money and spends it as he pleases; that his pretense of working for the benefit of the dear public and the future settler is the rankest hypocrisy, and that he has been and now is fighting solely for the benefit of the land-grabbing Octopus and because he is paid for every speech and every article that he has written and published on this matter.

Maxwell's testimony, which follows, is printed in Congressional Record under date of April 1, 1904, and copies of this record may be had by any person addressing the congressman from his district.

MR. HITCHCOCK—Have you access to the list of railroad subscribers to this fund in support of your movement.

MR. MAXWELL—Certainly.

MR. HITCHCOCK—Could you file it with the committee?

MR. MAXWELL I can tell you just what it is.

MR. HITCHCOCK—I want to perfect some information I asked for. When you gave the name of the railroads that had contributed to these various funds you did not state the amounts they contributed.

MR. MAXWELL—Six thousand dollars for each of the transcontinental lines and the Burlington and $3,000 for the Rock Island.

MR. HITCHCOCK—That makes how much altogether?

MR. MAXWELL—Thirty-nine thousand dollars.

MR. HITCHCOCK—Now, for what purpose is that money used?

MR. MAXWELL—It has been used for the expenses of the National Irrigation Association, and there has only been a part which has been available by that association for the circulation of its literature and the maintenance of our press bureau and the educational campaign which we have been carrying on for the last five years.

MR. HITCHCOCK—That is an annual contribution?

MR. MAXWELL—Yes, sir.

MR. HITCHCOCK — Has been going on for five years?

MR. MAXWELL—Yes, sir.

MR. HITCHCOCK—And still continuing?

MR. MAXWELL—Still continuing.

MR. HITCHCOCK—Six thousand dollars each for the transcontinental lines, the six of them?

MR. MAXWELL—I include the Burlington.

MR. FRENCH—What one pays less than $6,000?

MR. MAXWELL—The Rock Island.

MR. FRENCH—That pays $3,000.

MR. MAXWELL—The funds of the association are drawn also from many different directions. This is only a part.

MR. MARSHALL—What part?

MR. MAXWELL—I think the fund exceeds $50,000 altogether.

MR. MARSHALL—Annually?

MR. MAXWELL—Yes, sir.

THE CHAIRMAN—Has your association, or did your periodicals, ever advocate the law upon the calendar which prohibits the scrip owner or these transcontinental railroads (some two and one-half millions of acres of these lands)—which prohibits them from locating valuable timber?

MR. MAXWELL—We advocate that every acre of valuable timber shall immediately be put in a forest reserve, and if any one here has a copy of my own paper I would like to refer to that. I would like to submit that to the committee when the opportunity occurs.

THE CHAIRMAN—Is it not true, on the contrary, that your association has taken occasion to ridicule legislation prohibiting the location of valuable timber land with the forest reserve lieu rights or scrip and the people who have proposed it?

MR. MAXWELL—I have taken occasion to take this position, which I am ready to take now or at any time, that in trying to remedy forestry matters and leaving the agricultural lands open to speculative entry you are saving at the tap and losing at the bung.

MR. MARSHALL—You started out by saying that you were working in accordance with the recommendation of President Roosevelt's message. Does not President Roosevelt concur virtually in the report of this commission?

MR. MAXWELL—There seems to be a difference of opinion in regard to that.

MR. MARSHALL—He says he sends it for favorable consideration.

MR. HITCHCOCK—Referring to this $50,000 fund, who controls the disposition of that? Do you?

MR. MAXWELL—We do.

In addition to the above amounts, which Maxwell admits having received from the railroads, he has frequently boasted that two thousand members of his National Irrigation Association have paid him from five dollars upward each per annum, making a total fund of about $20,000 annually from this source alone. Maxwell is therefore known to have received at least $70,000 per annum, and it is believed that he has received $25,000 or $30,000 additional from the big land combinations and other sources, making a total fund of about $100,000 a year, of which he has had absolute control and disposition.

Maxwell stated in Washington recently that he was not particularly interested any longer in this fight because during the years he had been employed by the Octopus he had obtained inside information and special privileges which were worth $200,000 to him personally, and that the contributions which will come from members of the National Irrigation Association will never be entirely cut off.

How long will the members of this association continue to pay money to this man, who makes no public statement of its disbursement and who has not, up to the present time, "delivered the goods." This same Maxwell is the chap who poses as the friend of the laboring man—a public benefactor! Ye Gods!

THE AMERICAN IRRIGATORS' LEAGUE.

An inter-protective association of irrigation farmers, homeseekers and homebuilders in the arid and semarid West and throughout the United States.

The American Irrigators' League is organized as an aid and adjunct to the National Irrigation Congress and to perpetuate the same as the only reliable organization to carry out the objects of the national irrigation laws, secure State control of the distribution of water for irrigation and to harmonize and unify the various diverse State irrigation systems into one uniform system.

OBJECTS OF THE LEAGUE.

The objects of the American Irrigators' League, in addition to those pertaining to the National Irrigation Congress, are specifically:

First—To agitate the passage of just, appropriate and beneficial land and irrigation laws by Congress and the State Legislatures, and to secure their honest enforcement and application and their speedy operation.

Second—To agitate for a uniform system of land and water laws, and for the speedy redress of local grievances and infringement of individual rights and to act as a tribunal of arbitration for the settlement of differences.

Third—To oppose land and water syndicates and combines organized for the purpose of oppressing water users; to protect actual and prospective settlers upon public lands against encroachments, frauds and schemes of private individuals or officials, and to collect evidence and provide for their exposure and punishment.

Fourth—By a system of inter-communication to keep its members informed as to the most improved and profitable methods of irrigation farming; profitable crops, best markets, locations of supply and demand and ruling prices for products.

HOW FORMED.

The league is divided into divisions, based on water districts, each water district constituting a local division, the members of which shall consist of actual settlers, who practice irrigation in whole or in part, or who have homes in the arid or semi-arid regions.

Congressional divisions corresponding with the congressional districts recognized by the Congress of the United States, and its members shall consist of members of the local divisions, selected in the proportion of one member of each congressional division to every ten or less members of said local division.

State divisions, the members of which shall be selected from among the congressional divisions in the proportion of one member of the State division to every twenty-five members of each congressional division, but said State division is in no case to exceed one member to represent every county in the State to which it belongs.

A national division, or congress, which shall consist of five members from each State, selected out of the State divisions, and shall be limited to five members from each State, selected as follows: One from each of the north, south, east and westerly portions of each State, with one member to be selected to represent the State at large.

This organization has developed a membership of 3,150, scattered throughout the Western States. New divisions are being rapidly formed. *Organize* your district or county *now*. For further particulars and membership blanks write

THE AMERICAN IRRIGATORS' LEAGUE,
1208 Boyce Building, Chicago, Ill.

IRRIGATION EXPERIMENTS IN ARIZONA.

Investigations Covering a Period of Four Years at the Experiment Station Farm at Tucson.

BY PROF. ALFRED J. M'CLATCHIE,
Agriculturist and Horticulturist of the Arizona Agricultural Experiment Station.

During the past four years, especially during the last half of that period, much attention has been given at the station farm to irrigation from various standpoints. One line of investigation has been the determination of the best method and the proper time for the irrigation of each crop grown in the region. Another study has been the amount of water needed by each crop, and the best procedure for conserving the water applied. The first crop studied carefully along these lines was the sugar beet. Next attention was turned to deciduous orchards. Later potatoes, corn, grains, melons, garden vegetables and other crops were given consideration. During the past season a beginning was made in studying the best method of irrigating Egyptian cotton, and the amount of water needed for producing a crop. Many data have been obtained that seem worthy of publication at this time, that they may become promptly available to the farmers of the territory. Meanwhile the investigations are being pursued with increasing intensiveness.

WATER SUPPLY.

The station farm, where were made the records that are the basis of this bulletin, is situated near Phoenix, just below the Maricopa canal, in the midst of typical Salt River valley farms. The surrounding region is devoted to the production of alfalfa, grain, orchard and small fruits and vegetables. The station farm (as are other farms of the section) is supplied with irrigating water from two canals (the Maricopa and the Grand, which in this part of the valley run about a half a mile apart) of the four main ones supplying with water the portion of the valley lying on the north side of the Salt River. The practice being to turn water through two of the four canals for four days and then through the other two for the succeeding four days, water can be obtained for irrigation twice during each eight days by contracting for the delivery of a portion through each of the two canals mentioned above.

The amount of water received from these canals fluctuates very much during the year, varying with the flow of the Salt River, from which they receive their water. When the river is high enough to make it possible, water is delivered to farmers continuously, or during four successive days with an intervening four days when none is delivered. But as the river falls, the "runs" are shortened more and more, until they may have a duration of but a few hours. Under such circumstances water is available for irrigation from any one canal upon but one day in eight, and small plants are apt to suffer for water, if the weather be hot and dry. By having water delivered through two canals, a farmer can irrigate strawberries, garden vegetables, and other shallow rooted crops every four days. This possibility has been especially necessary during the past two summers while water has been so low. Without water being available every four days, it has been practically impossible to maintain a field of strawberries, for example, through the past three trying summers, and in many cases a large percentage of the plants of a field have been lost though watered every four days.

The cause of the fluctuation of the river flow will be indicated by the following table of the average precipitation at the six stations in the water shed of the Salt and its tributaries, according to the available records:

Average Monthly	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation in inches.	1.84	1.46	1.57	0.81	0 64	0.30	2.27	2.57	1 20	0 95	1.08	1.90

WATER REGISTER.

The variation in the supply of irrigating water from month to month will be indicated by the following table of the flow of the Salt River during the past thirteen years, based upon the available records.

TABLE 1.—MONTHLY FLOW OF SALT RIVER IN 1,000 ACRE FEET.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1889	365	144	537	236	63	27	30	25	31	27	34	349	1871
1890	306	560	394	109	56	30	32	238	139	160	280	384	2688
1891	210	2175	300	160	150	79	46	48	34	30	30	40	3302
1892	41	170	50	60	30	22	24	18	27	30	33	19	528
1893	33	83	188	86	48	13	35	100	65	46	35	38	770
1894	17	32	86	50	40	30	30	60	60	60	30	170	665
1895	600	173	340	154	58	28	20	57	30	128	108	75	1771
1896	48	36	89	70	37	20	90	100	60	170	60	50	830
1897	335	170	70	50	88	31	49	33	100	54	32	33	1045
1898	37	61	83	67	40	23	46	49	41	20	24	38	529
1899	40	38	40	44	24	17	37	40	26	38	25	25	394
1900	26	26	24	25	28	9	6	18	14	21	33	26	256
1901	56	195	105	60	45	20	20	59	17	15	23	22	637
Aver	158	293	170	90	54	27	36	65	52	61	57	97	1157

It is a significant fact that although the rainfall is heavier in the watershed of the Salt River during July and August than during the winter, the flow of the river is usually much greater during the latter season. The parched condition of the watershed and the rapidity of evaporation during the hot summer months are undoubtedly responsible for the failure of most of the rainfall of that season to reach the valley below. During the months of December, January and February an average of over three times as much water is available for irrigation as during the summer period of most abundant rainfall. But it is naturally during the summer months that the most water is needed for irrigation. The season of greatest need is from February to July. During considerable of this period, especially during May and June, the river, as will be seen by referring to Table I, is commonly low and the supply of

irrigating water consequently short. This being the season of greatest growth, it is important that crops be supplied with plenty of water. In order to provide for this demand on the part of the crop, the application of large amounts during the winter and early spring is practiced by most farmers. This method is especially useful in the case of orchards and alfalfa, and can be resorted to for soaking soil intended to be used for spring crops. Thus, water is commonly applied at the station farm, and upon other farms of the region, not when most needed by the crop, but when it is available. This is a condition that naturally exists where flood waters are not stored in catchment basins along the river. The beneficial results coming from such a reservoir can be most nearly obtained by using the soil itself as a storage reservoir. It is hoped that the experiments reported upon in this bulletin, and others in progress, will help farmers to realize the possibilities along this line. Next to storage reservoirs for impounding flood waters, the greatest need of the region is a better understanding of the best way or ways of obtaining the greatest return from the water available for irrigation. While steps are being taken to procure storage facilities in southern Arizona, all can practice economy in the use of water, and thoughtfully make the best of the existing conditions.

SOIL OF THE STATION FARM.

The soil of most of the station farm is a clayey, gravelly loam underlaid with a stratum of gravel. The loam is five to six feet deep, and the gravel stratum about eight feet thick, beneath which lies a stratum of fine clay about twenty feet deep. The loam of a portion of the farm is overlaid with a fine adobe, the superimposed stratum varying in depth from a few inches at one side of the section to six to eight feet at the other side. The adobe soil is moistened more slowly than the loam, and retains its moisture longer. Both become quite hard, if permitted to dry without cultivation at the proper stage of desiccation, the adobe soil cracking as it dries. The period during drying when the adobe soil may be cultivated is especially short. In the case of either soil it is very important that a cultivation be given at just the right time, in order to maintain a proper physical condition of the soil. Water does not percolate rapidly through the adobe or the loam stratum; but when it once reaches the gravel, it passes downward rapidly until the clay is reached. Hence only deep-rooted crops, such as alfalfa and fruit trees, are much benefited by water that passes beyond the stratum of loam. Determinations of the maximum water capacity of the soil of the loam stratum show that the amount of water required to saturate it is approximately two and one half feet. Determinations of moisture content made from samples taken a few days subsequent to irrigation, when superfluous water applied had had time to settle away, showed that the soil as it lay above the gravel had the power to hold about one and one-fifth feet of water. Hence the latter amount is about what would be necessary to apply to this soil, if thoroughly dry, to put it into good condition for the growth of any of the crops reported upon, except the orchard fruits. Moisture determinations made when the soil was so far dried out that most crops would suffer for water showed the presence of a little over one-half foot of water in the loam stratum of five and one-half feet. Thus the amount of water that might be economically applied at any irrigation would be theoretically the difference between 1.2 feet and .5 feet, or about .7 feet. This agrees very closely with the amount that experience has shown to be necessary to apply at

TYPICAL ARTESIAN WELLS AND RESERVOIR NEAR ST. DAVIDS, ARIZONA. PHOTOGRAPHED BY W. W. SKINNER, UNIVERSITY OF ARIZONA AGRICULTURAL EXPERIMENT STATION.

one irrigation in order to bring soil in which most crops would suffer to a good state of moisture. Of course the exact amount will vary with the kind of crop and with the stage of its development. For instance, crops planted in wide rows need considerably less water during early growth when plants are small, than later.

SEASON OF GROWTH.

Although there is no season of the year when some crop or crops are not growing on the station farm and on the other farms of the region, yet there are two seasons during which most are produced: (1) November to March inclusive, when grains, most hardy vegetables and small fruits are planted and make the main part of their growth; and (2) April to October inclusive, when melons and other vegetables more sensitive to frost than to heat, corn, cowpeas and sorghum make the most of their growth.

But there is no time of the year when some crops are not maturing and others in the early stages of their growth. The time when fewest crops overlap in this way is about the time of the fall frosts that occur about the middle of November. By this time the summer crops sensitive to frost are either mature or are killed, and few of the winter crops are planted. Hence this is the most appropriate time to make a beginning of the crop year. Each irrigation year reported upon below is considered as extending from the end of November, 1900, to the end of November, 1901.

RAINFALL DURING YEARS COVERED.

While precipitation may occur at any time of the year in the vicinity of Phoenix, there are two seasons during which the fall is heavier than during the remainder of the year, and the consequent supply of irrigating water much greater. The two seasons are, respectively, July and August, and from December to February inclusive, the rainfall being usually the heaviest during the last month of the year. The rain and snow falling in the mountains during the winter rainy period usually furnish an increased supply of irrigating water until the end of March. From the latter month until July the rainfall is light and the supply of water usually gradually diminishes, becoming very low during June. The summer rains swell the streams and increase the supply of irrigating water temporarily. Then follow about three months during which the rainfall is so light that the supply is again usually less than the demand.

The following table of the average rainfall in inches for each month of the year, as recorded during the past twenty-six years, will indicate how the rainfall is distributed through the year at Phoenix:

Average Monthly Rainfall 1875-1901	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Tot.
	06.2	0.75	0.61	0.30	0 15	0.10	0.99	0.95	0.46	0.45	0.54	1.27	7.18

It will be seen that the average monthly precipitation gradually decreases from the winter rainy season until July, during which month and the following one the average amount is somewhat above the average rainfall for the respective months of the winter rainy season.

The average monthly amount of precipitation being so small, the amount that falls during any one day is seldom great—too small usually to be of much direct benefit to growing crops. The principal local benefit is due to the temporary raising of the relative humidity of the atmosphere near the surface of the soil, thus checking evaporation and causing more of the irrigating water to be available to the growing plant. If a rain can be followed with an irrigation, that the moistening of the soil may be continued downward to the

WATERMELONS AFTER TEN IRRIGATIONS.

moisture below, then the rain may be a distinct benefit. In any case, shallow-rooted crops are often temporarily benefited, but unless a cultivation can follow, the soil at and near the surface usually soon becomes baked and the crop is often worse off than before the rain. The crops benefited most by the local rains are the winter grains. Being shallow rooted, and growing during the cool time of the year when evaporation is less rapid than at other times, they often receive considerable benefit from the rains of December, January and February. Some of the July and August showers benefit such crops as strawberries, tomatoes, and other shallow-rooted ones. But the effect of a rain upon a crop is seldom lasting, and only a small portion of that which falls can be considered as consumed by a growing crop.

Of greater importance than the local rains are the storms in the mountains constituting the watershed of the Salt River, the source from which the irrigating water is drawn. As the mountain rains usually occur at the same time as the valley rains, the latter are usually welcomed because of the simultaneous occurrence of the former, rather than because of their own direct value.

RAINFALL FOR 1898 AT STATION FARM.

	Inches.		Inches.
January 10	.60	November 26	.53
January 13	.22	November 27	.01
January 27	.70	December 9	.63
July 4	.20	December 10	1.31
August 22	.30	December 11	.02
August 26	.70	December 16	.02
November 25	.07		
		Total	5.31

The rainfall of the year, it will be observed, all fell during but five months of it, none falling from January to July, nor during September or October. The rain was thus confined almost entirely to the two rainy seasons mentioned above. As usual also, the greatest amount fell during December.

RAINFALL FOR 1899 AT STATION FARM.

	Inches.		Inches.
January 11	.23	July 24	.12
January 12	.97	July 31	.14
February 2	.09	August 3	.81
February 3	.02	August 6	.18
June 24	.29	August 15	.54
June 25	.76	September 8	.89
July 9	.16	October 11	.29
July 10	.01	October 12	.01
July 12	.12	October 14	.04
July 15	.03	November 14	.42
July 18	.33	November 22	.06
July 19	.33	December 18	.12
		Total	6.96

The rainfall of this year was distributed more evenly, fell in a large number of showers, and exceeded in total amount that of the year preceding. An unusually small amount fell during February and December, and an unusually large amount during June. It will be noted that none fell during March, April or May.

RAINFALL FOR 1900 AT STATION FARM.

	Inches.		Inches.
January 4	.10	August 3	.03
March 13	.10	September 1	.08
March 14	.13	September 22	.01
March 25	.03	October 12	.20
April 5	.56	November 17	.44
April 28	.39	November 18	.64
May 5	.10	November 19	.67
July 20	1.30		
		Total	4.65

The rainfall this year was abnormally small during the winter rainy season, but one-tenth of an inch falling during that period. This was partially compensated for by the unusual rainfall for April. The rain of July 20 and of November 17-19 was sufficient in amount to directly benefit growing crops. It will be noted that none fell during February, June or December. The total precipitation was below that of any previous year since a record has been kept at the farm.

RAINFALL FOR 1901 AT STATION FARM.

	Inches.		Inches.
January 25	.38	July 24	.07
January 27	.04	July 27	.05
February 1	.36	July 29	.59
February 3	.02	July 30	.02
February 6	.68	August 1	.06
February 7	.05	August 3	.97
February 10	.11	August 4	.01
February 11	.01	August 5	.02
February 24	.03	August 11	.22
March 8	.09	August 12	.06
March 31	.14	August 13	.05
May 14	.15	August 17	.14
May 29	.06	August 29	.21
July 2	.01	October 29	.55
July 23	.08	November 12	.13
		Total	4.36

The year was characterized by the unusual number of showers that fell, especially during February, July and August. With the exception of the absence of rain during December, as during the previous year, the precipitation fell during the usual rainy seasons. The total of the thirty showers was, however, smaller in amount than that of any previous year of which there is a record at the farm. On very few days did enough fall to be of much direct benefit to crops. However, during the winter season, three rains, varying in amount from one-third to two-thirds of an inch, occurred that would benefit growing grain. But the total amount, 1.42 inches, is small compared with the amount required to produce the crop. One of the July showers—that of the 29th—and one of the August ones—that of the 3rd—would also benefit considerably some of the summer crops, such as strawberries, tomatoes and cotton. Possibly an average of a tenth of a foot might be counted as the amount of rain utilized by each crop, in addition to the irrigating water applied during the year. It will be noted that during March, May and the most of July, the rainfall on no date was sufficient to wet dry soil to a greater depth than one-half inch, that none fell during April or June, and none during the two months from August 29 to October 29.

TEMPERATURE AND RELATIVE HUMIDITY.

The coolest months at the station farm are December and January, during which frosts (occasionally heavy ones) are frequent. During February the weather commonly becomes gradually warmer. It may be considered that this month marks the beginning of spring. The principal part of the growth of winter-sown crops is made during the three months that follow. During these months the weather becomes increasingly warm, the maximum temperatures, by the latter part of June, ranging from 100° to 110° F. in the shade. The relative humidity of the atmosphere decreases as the season advances and the temperatures rise, evaporation consequently becoming very rapid. During July and August the temperature is higher than during June; but the humidity is temporarily increased from time to time by rains and the weather is consequently often less try-

ing upon vegetation. From August to December the weather commonly grows gradually cooler, and the relative humidity usually increases.

The accompanying table of the average monthly temperature and relative humidity during the four past years will indicate the changes in the weather from season to season of the year, and what the weather of the period has been. The temperatures are those at the farm, and the relative humidity figures, those obtained at the Weather Bureau at Phoenix:

TABLE II.—TEMPERATURE AND RELATIVE HUMIDITY.

	Mean Temperature.				Mean Relative Humidity.			
	1898	1899	1900	1901	1898	1899	1900	1901
January	46	47	53	52	56	49	41	47
February	57	51	53	55	41	40	29	59
March	54	59	63	59	33	32	38	38
April	70	67	62	64	30	28	44	29
May	72	70	76	73	27	22	26	30
June	83	83	84	81	25	32	16	19
July	89	90	90	91	37	40	25	33
August	88	86	85	88	44	38	26	43
Sepetmber	82	84	77	81	32	31	30	28
October	70	67	69	71	23	40	36	39
November	56	58	60	61	35	46	41	49
December	47	50	52	50	51	38	42	32
Annual Mean	68	68	69	69	36	36	33	37

It will be seen that the mean annual temperature and the mean relative humidity differ from year to year far less than the rainfall. The changes in the temperature from month to month are, on the whole, quite regular. Only a few marked irregularities occurred during the four years. One of these was the lower mean temperature during March, 1898, than during February, and another the lower mean temperature during April, 1900, than during March. The coolest month during the four years was January, 1898, and the warmest, July, 1901. The dampest month during the period was February, 1901, and the dryest, June, 1900, the latter year being the dryest of which there is a record at the Phoenix weather bureau. It will be noted that July has been uniformly the warmest month of each of the four years.

EVAPORATION.

The rate of evaporation from plants, from soil, or from water, varies with the temperature, the relative humidity, and the wind velocity, the rate from soil being affected less by the last factor than the rate from water. The amount of evaporation from water indicates approximately the rate of loss of water from crops and from soil. Consequently evaporation data are helpful in considering irrigation questions.

The record of evaporation from a water surface has been kept at the farm for but one year. The beginning was made last April and a record is now being made regularly. The record is being kept in the usual way from the surface of a tank of water sitting with the surface even with the surface of the soil. The results for May to November (end of the last irrigation year), inclusive, are given in the table that follows:

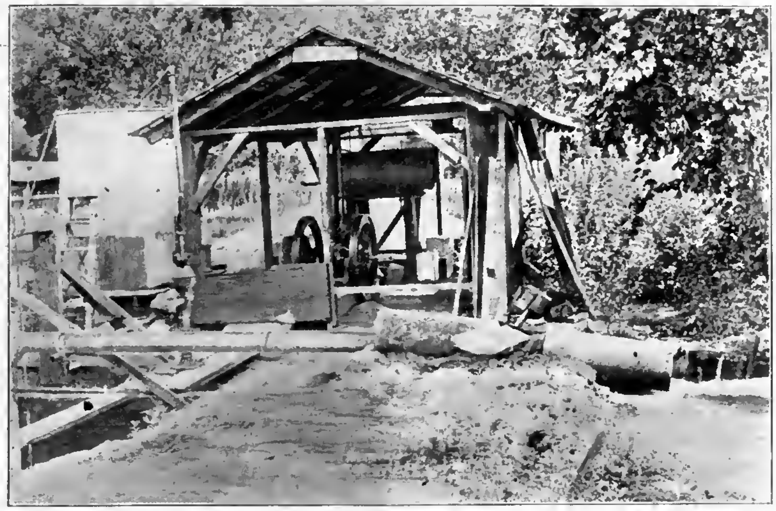
TABLE III.—EVAPORATION FROM WATER SURFACE.

Week ending	Evaporation in inches.	Week ending	Evaporation in inches.
May 7th	1.68	August 27th	1.68
May 14th	1.92	September 3rd	1.56
May 21st	1.92	September 10th	1.68
May 28th	2.04	September 17th	1.80
June 4th	2.04	September 24th	1.68
June 11th	2.16	October 1st	1.56
June 18th	2.04	October 8th	1.32
June 25th	2.28	October 15th	1.08
July 2nd	2.28	October 22nd	1.08
July 9th	1.92	October 29th	.84
July 16th	2.52	November 5th	.48
July 23rd	2.64	November 19th	.36
July 30th	2.52	November 26th	.48
August 6th	2.88	December 3rd	.48
August 13th	.72		
August 20th	1.44	Total	49.48

The total of the seven months—approximately 49½ inches—was divided among the months as follows: May 8.28 inches, June 9.42 inches, July 11.29 inches, August 6.55 inches, September 7.08 inches, October 4.81 inches, and November 2.05 inches.

The comparatively low evaporation for the week ending August 13th, due to the humid condition of the atmosphere, is a striking illustration of how evaporation is modified by such a condition. It will be noted that though the temperature was higher during August than during September, the evaporation was greater during the latter month. This was due to the frequent showers of August, and the absence of rain during September. From the latter month to the end of the year the rate of evaporation decreased gradually and quite regularly.

The evaporation for December, 1901, to April, 1902, inclusive, amounts to 16.15 inches, making a total of 65.63 inches for the year during which a record has been kept.



SMALL GASOLINE ENGINE RAISING SANTA CRUZ UNDERFLOW FOR IRRIGATION. PHOTOGRAPHED BY W. W. SKINNER, UNIVERSITY OF ARIZONA AGRICULTURAL EXPERIMENT STATION.

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,
Expert in Drainage and Irrigation U. S. Department of Agriculture.

"In the cultivation of retentive soils," says Waring, "drainage is the key of all improvement."

Farmers frequently desire an improvement in methods and in the general management of their lands without being sufficiently informed regarding the specific changes that will be necessary to bring it about or clear in their minds as to the profits that would accrue should such changes be made. When a farmer finds his land too wet for cultivation, he admits the necessity of drainage for the time being, but often hopes that the following season may be more favorable—which hope is frequently realized—and so takes the loss as one of the contingencies of the industry. He waits in the spring for slow natural drainage and evaporation to relieve his land of the surplus water and permit the sun to dry and warm the soil sufficiently for the reception and germination of the seed, when by the aid of drainage the seeding could be done a week or ten days earlier. The injury resulting to crops growing upon land imperfectly drained when the season is not the most favorable is frequently taken as unavoidable—one of the vicissitudes of farming rather than a loss to be prevented by the use of well located and constructed drains.

Facts which are easily discerned by the casual observer have pressed the subject of drainage home to both practical farmers and non-resident landowners in a most emphatic way. Those who have gone further into the subject of soil improvement by drainage have discovered greater advantages and more surprising benefits than were formerly thought possible. It is conceded to be a necessary accompaniment of scientific agriculture, and our most progressive farmers have taken advantage of it to a greater extent than is generally supposed. It is an improvement applicable to all land not possessing natural drainage, and hence is required for the attainment of the best results from some of our most fertile land. The farmer, when convinced that it will be to his interest to construct some kind of a drainage system for the improvement of his soil, desires to know how to plan and perform the work in an effective way at an expense not exceeding the limit of profitable returns which can reasonably be expected. He will find it an advantage to have an intelligent idea of the theory as well as of the practice of drainage in order that he may adapt his work to the several varieties of soil and conditions with which he has to deal.

NATURE OF A DRAINED SOIL.

A drained soil is one which is moist but not saturated with water. Soils used for the production of the plants most prized by the farmer, gardener, or fruit grower must, in addition to other necessary elements, contain a certain percentage of water in order to yield the largest possible returns. This is usually termed "moisture," and soils in which the proper percentage of moisture exists are commonly called "dry soils," to distinguish them from those containing a surplus of water, which are called "wet soils." The farmer, therefore, in speaking of a "dry" soil does not mean one which is devoid of water, but one which does not contain enough water to hinder or prevent the growth of his plants, while the term "wet" indicates one that contains more water than is needed, the presence of which prevents the plants from reaching their greatest perfection. A perfectly dry soil is dead, and is worthless for producing crops. A soil which is completely saturated with water will produce nothing but aquatic plants and hence is worthless for cereals and other valuable products.

Plants take their nutriment from the soil in liquid form only, it having been prepared by the action of heat and moisture on the elements present. An excess of moisture reduces the temperature, excludes the air, and dilutes the plant food, thus retarding or entirely stopping the growth of the plant as effectually as a lack of moisture.

MECHANICAL MAKE-UP OF SOILS.

Soil is made up of exceedingly fine particles of irregular shapes, varying composition and different properties. It is formed by the breaking down of rocks of different composition which are disintegrated by the weather, ground up and distributed by glacial action and floods, and mixed with the products of successive ages of vegetable growth. These particles as they appear under the microscope are rough and irregular, some of them being exceedingly small. The differences in size of the particles of ordinary soils (exclusive of gravel, pebbles, etc.) are illustrated in the following classification usually adopted in the mechanical analysis of soils:

COMPARATIVE DIAMETERS OF SOIL PARTICLES IN DIFFERENT SOILS.

	Inch.
Coarse sand	0.04 to 0.02
Medium sand	.02 to .01
Fine sand	.01 to .004
Very fine sand	.004 to .002
Silt	.002 to .0002
Clay	.0002 and less.

The peculiar shapes of soil particles as they appear under the microscope are shown in Figs. 1 and 2. Here it is shown that the particles of sand are not less than

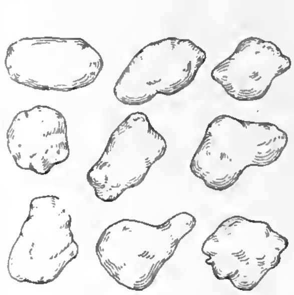


FIG. 1.—Soil particles magnified 162 times.*

FIG. 2.—Silt particles from subsoil magnified 225 times.*

200 times larger than the particles of clay.

As the soil particles can not lie together so as to form a solid mass, there is a large amount of intervening space, which in an average soil equals nearly half its volume. The smaller the particles the greater the proportion of space. Thus clay contains 65 per cent of space, while a sandy truck soil contains 37 per cent, ordinary soils varying all the way between these extremes.

As a result of a force which is known as surface tension, each particle of soil holds a film of water over its entire surface and thus provides a supply of this material for the roots of the plant. When the quantity

*From Bulletin No. 187 issued by U. S. Dept. of Agriculture.

of water in the soil is so much greater than is required to supply that which is held by surface tension that the remaining space is filled the soil is said to be saturated. If we provide an outlet for the water the surplus will pass off by force of gravity, leaving only the films which are held by surface tension and which furnish the desired moisture to plants. Thus from 15 to 20 per cent of all the water which a soil will hold will not pass off as drainage, but will remain as capillary water to contribute to the growth of plants, and to aid further in the preparation of additional plant food. This necessary moisture moves through the soil independently of gravity by the force of capillary attraction or surface tension—as illustrated in the rise of liquids in small tubes and between surfaces of solids which are close together—which tends to distribute and equalize moisture in the soil. Where the principal supply is above or in the surface layers, it is drawn downward; where it is below it is drawn upward.

As before stated, about 50 per cent of the volume of ordinary soils is space which is always filled with water or air. The individual spaces are larger or smaller according as the soil grains are more or less minute. A close clay soil and a very coarse sandy soil will illustrate the extremes of difference. The fine grains present more surface in a given volume of soil and hence will retain the greater quantity of moisture. The coarser soils will permit a much freer percolation of water and hence quicker drainage than the finer ones, since the closeness of the particles offers an additional resistance to the passage of water by gravity through the soil.

Another mechanical condition of soils has more to do with their drainage properties than the differences already noted. It is the massing of particles of different character to form compound soil grains which lie contiguous and have spaces between them. Those who have examined the physical structure of soils minutely will

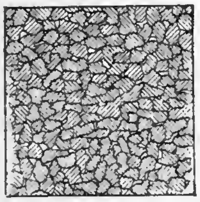


FIG. 3.—Soil grains and spaces.

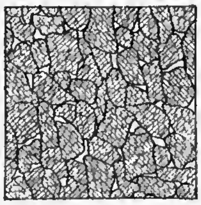


FIG. 4.—Soil particles in masses.

FIG. 5.—Joint clay structure.

have observed the granular structure of soils containing a mixture of humus and clay. Some subsoils are commonly known as "joint clays" from the fact that they show natural cleavage or fractures which mark them as soils easily drained. Others of a marly, sandy, or gravelly nature mass their particles into irregular forms which can not lie close together, and are known as light subsoils. Still other clays appear to be wanting in the characteristics named, their individual particles lying compactly together and forming a dense mass capable of retaining a larger percentage of water than any other variety, and are commonly known as retentive or impervious soils. Some of these mechanical characteristics are illustrated in Figs. 3, 4 and 5.

The varieties of soils and the numberless combinations which their particles assume in such a way as to materially affect their drainage properties can not be described here. Indeed, the structure of a given soil can not be known until a personal examination and test have been made. The reading of soils for drainage operations requires a skill which can not be imparted without special field lessons; yet any close observer may soon acquire a fair degree of proficiency in judging soils within the limits of the area with which he is concerned.

*From Bulletin 65, Minnesota Experiment Station.

NATURAL AND ARTIFICIAL DRAINAGE.

Some of our best soils have perfect natural drainage. They are underlaid with strata of material which give free passage to surplus water and are composed of elements which respond readily to the efforts of the cultivator. On the other hand, there are soils just as rich in natural fertility which are unproductive because under all ordinary circumstances they contain too much water. Whether the excess of soil water is caused by rainfall direct or by seepage from lands which occupy a higher level, the surplus water must be removed before the soil will be in proper condition for plant growth.

The process of drainage, either natural or artificial, only regulates the quantity of water in the soil by providing the means by which its surplus may pass off by gravity, and in no case removes the moisture required by plants, since such moisture is retained by the particles of soil.

SURFACE DRAINAGE AND UNDERDRAINAGE.

Surface drainage, as commonly understood, is accomplished by open ditches which, in addition to receiving and removing water from the surface of land contiguous to them, may, if sufficiently deep, act as receiving drains for water which percolates through a porous substratum through which the ditches are excavated, and under such conditions facilitate underdrainage as well as carry off water from the surface. The advantages of removing water downward through the soil instead of over the surface may be briefly stated as follows:

The surface soil is retained entire instead of the finest and most fertile parts being carried off with every considerable rainfall.

Any plant food in manure or other fertilizer deposited upon the soil is carried into it with the water as it percolates downward from the surface, and so becomes thoroughly incorporated with the soil.

Rain water as it passes through the soil serves a most useful purpose by dissolving and preparing crude soil material for the nutrition of plants.

The soil, having been well prepared, is at all times during the growing season in readiness for the growth of plants, such growth not being hindered by stagnant water or saturation.

The frost goes out earlier in the spring, so that the planting season opens one or two weeks earlier than in the case of soils affected by surface drains only.

Where stiff clays are found the soil is made more porous, open and friable, and roots penetrate more deeply than they do into surface-drained soils.

The effects of drought are diminished, as has been found by experience, owing to the enlarged and deepened soil bed and to the more favorable condition of the surface for preventing excessive evaporation of moisture.

It aids in making new soil out of the unprepared elements, since it permits a freer entrance of air and atmospheric heat which disintegrate soil material hitherto unavailable for use of plants.

Stubborn and refractory soils when drained are frequently so changed in texture and mechanical structure that they become easily managed and respond to cultivation with abundant crops.

OPEN DRAINS.

Underdrainage is that which directly affects the soil and puts it in proper condition for plant production. Provision for it assumes that sufficient natural water courses or artificial channels exist to carry off the water discharged by such underdrains as it may be found wise to use. It is often the case, however, that outlet channels must be provided before a system of underdrains which will operate successfully can be laid. Natural streams are often insufficient and should be improved in size and alignment. In fact, the location and water-carrying capacity of general outlets as related to the drainage area should receive particular attention in the formation of drainage plans. When it is desired to reclaim and improve large areas of level land, such tracts must be cut up into sections or districts by large open ditches in order that tile drains may be laid in every part without necessitating the use of mains too large and costly to be profitable. While these open ditches are not desirable in themselves, since the land they occupy can not be used for any other purpose, and though they often divide the land into tracts of inconvenient shape, yet they are necessary to every system of underdrainage. They should be located with care, following the course of natural drainage as nearly as may be, with due regard to straight courses.

When these outlet ditches are located on land belonging to one individual, he has merely to construct them as he chooses and pay the cost of the work. But in all large tracts in which a number of landowners have interests, open ditches must be constructed by the coöperation of all parties benefited. In several States methods of doing this are provided for by statute. Outlets for the drainage of tracts varying from a few hundred up to many thousand acres have been provided for in this way, each owner within the district paying a share of the expense of such work proportionate to the benefit he derives. It is intended that when these main channels have been made, each owner shall be provided with an outlet for his drainage and that all subsequent drainage of his own land shall be done at his own expense, without in any way infringing upon the rights of others, while the general outlet will be controlled by the proper officers as provided by law.

The method of improving natural channels is often suggested by the contour of the land and the conditions surrounding the tract to be drained. Such channels are usually crooked to a troublesome degree, and necessitate the division of the fields into inconvenient shapes. They are sometimes well defined by strong banks which can be changed but slightly. In other instances, where the channel winds through a tract of bottom land, it can be greatly improved by cutting off the bends and making the course as nearly straight as practicable. Because natural ditches and streams are always crooked it does not follow that artificial drainage channels should be the same, especially where they extend through tracts where only light grades can be obtained.

Ditches upon rolling land may differ from those on level land in several important particulars. Those for the former, having a grade which gives a rapid flow, may be comparatively small and shallow. The outlets for tile-drains may, if necessary, discharge at shallow depths, since the lateral slope of the land is such that the drains may be laid at the desired depth only a short distance from their outlets. They may have narrow bottoms, since the velocity of flow is sufficient to scour and deepen them. In level land, however, it is often necessary to provide for practically the entire drainage, with but little assistance from the natural slope of the land. The depth of ditches with grades of from 1 to 4 feet per mile should ordinarily be not less than 6 feet and the bottom width not less than 4 feet. The side slopes in loam or clay soils may be made at an angle of 45°, or what is called a slope of 1 to 1. Where the soil is loose and sandy, the slope should be 2 feet horizontal to 1 foot vertical, called a slope of 2 to 1. Ditches excavated with teams and scrapers can not be profitably made with slopes less than 2 to 1.

CONSTRUCTION OF DITCHES.

The well-known method of making ditches with a plow and scoop scraper need not be described. Where the earth is sufficiently dry to afford a footing for teams and for the operation of the plow and scraper, it is an economical method of making ditches. Where the earth is dry, ditching contracts are sometimes let to farmers, who do the work when farm labor is slack, at from 7 to 10 cents per cubic yard. Ordinarily contractors will bid for such work at 10 to 14 cents under the conditions usually encountered. A large part of open-ditch work must be done when the ground is wet and in swamps under conditions where it is impossible to use teams. It is also necessary at times to make deep excavations, where water is sure to be encountered and where the earth is of such a character that it can not be handled by teams and scrapers.

There are machines which have been tried and found adapted to the work where the ordinary scraper can not be employed. For the making of small and shallow ditches what is known as the capstan ditch plow is used in some localities. It is an immense plow, which makes a ditch by cutting and throwing the earth from the center each way, its action being similar to that of a common sod plow. There are wings which push the earth thrown up 3 feet away from the edge of the ditch, leaving it in a large, continuous ridge on each side. The plow is pulled by two capstans, each of which is turned by a team of horses. The capstans are anchored ahead and their winding drums are attached to the plow by wire ropes. This machine makes a clean-

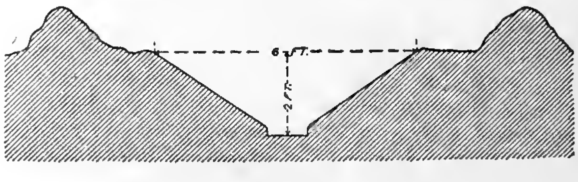


Fig. 6.—Section of capstan ditch.

cut ditch 8 feet wide at the top, 1 foot wide at the bottom, and ordinarily limited in depth to 2½ feet. It is used on Iowa and Minnesota prairie lands where it is thought that ditches of this kind will serve the desired purpose. Contract work is taken at about 60 cents a rod for the completed ditch. In order to operate the plow the earth should be saturated with water, so that it may be cut easily and will slip from the wings readily. A section of a finished ditch is illustrated in Fig. 6.

In the construction of artificial channels for the purpose of reclaiming large areas of level land there is

no method so satisfactory as that in which a steam dredge is used. These dredges as constructed for such purposes are of three different types. One, known as the floating dredge, begins operations at the upper end of the channel and works toward the outlet. There must be sufficient water in the ditch to float the boat which carries the engine and excavating machinery. The excavated earth is deposited on each side of the ditch at a distance of 6 to 12 feet from the edge of the channel. This style of dredge is adapted to the excavation of large channels, varying from 12 to 60 feet wide and as deep as is usually required. It has been successfully used in the middle West for twenty years and has done more toward the reclamation of level lands than any other agency which can be named. The sides of the ditch as usually excavated have a slope of about ½ to 1, and when completed a section has approximately the form of the letter U. Where the ground is quite unstable the side slopes should be not less than 1 to 1, and the excavated earth should be left not nearer than 8 feet from the edge of the excavation.

Another type of steam dredge will make ditches as narrow as 4 feet at the bottom and as wide as 12 to 15 feet at the top, with side slopes of 45°, the depths ranging from 4 to 9 feet. This machine is placed at the outlet of the proposed ditch and is pulled upgrade by means of a drum which winds up a cable previously anchored ahead of the machine. No water is required in the ditch in order to operate it. It excavates to its full depth and grade and completes the work from the outlet toward the source. The machine is not used as generally as the floating dredge, not because it is less efficient, but, being adapted only to the excavation of smaller ditches where the ground is firm on both surface and bottom, it is limited in its field and hence not so much in favor with contractors.

The third steam machine which may be described has similar limitations. It is constructed to move upon the surface of the ground in advance of the excavation, instead of following up the bottom of the ditch, as does the one last described. The plant carrying the machinery rests upon long runners which slide upon movable cross blocks, and is pulled by a cable, one end of which is attached to a winding drum at the engine and the other to a log anchored some distance ahead of the machine, technically called a "dead man." The mechanism for excavation consists of two dippers which are filled by being pulled toward the machine against the earth and are dumped alternately. While one dipper is filling the other is being swung to the opposite side and emptied. This dredge, like the last mentioned, is adapted to ditches of the smaller class and to land which is sufficiently firm to support the machine upon the surface.

Dredges of the three types just described have been in successful operation for ditching purposes for twelve to twenty-five years. The boats are built and the machinery mounted upon the ground where the work is to be done. The machines cost not less than $5,000 each. They are operated by contractors, who provide themselves with full equipment and do the work by the cubic yard, under specifications and measurements made by an engineer. The work required by these machines is performed at a cost of 7 to 13 cents per cubic yard, large contracts being taken at lower figures than small ones. Any of the dredges can excavate the larger and longer channels required for drainage at a much less cost than can be done by any other method.

SECTION AND BEHAVIOR OF DITCHES.

It has been found by experience that ditches may be constructed with sides more nearly vertical than was formerly thought practicable. In stiff loams and clays it is not desirable to cut the sides with slopes greater than 1 to 1. Ditches made with the floating dredge usually have slopes of about ½ to 1. In any case, those which carry large volumes of water change their form

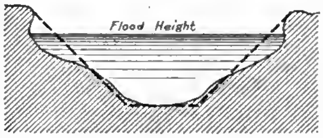


FIG. 7.—Change in section of ditch by erosion where side slopes are 45 degrees.

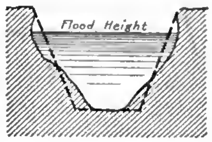


FIG. 8—Change by erosion in section of ditch with steep side slopes.

by reason of erosion and weathering of the earth and assume approximately the forms illustrated in Figs. 7 and 8, so that it is of greater importance to secure ample bottom width, in order to allow for this change, than to attempt to make the exact slope desired and expect it to remain as left by the machine.

The excavated earth, which of course lies in unsightly masses along the edges of the ditch when the work is finished, will, after weathering through one winter, assume a much less formidable shape and can in a year or two be worked down with a plow and scraper until the land can be cultivated nearly to the bank of the ditch. It is always well, however, to keep a strip on each side bordering the ditch in grass in order to prevent the banks from crumbling and to keep the adjoining cultivated soil from being washed into the ditch in times of sudden and violent freshets.

The grades upon which such ditches may be constructed are 6 inches per mile and upward, but a grade of 3 feet per mile is required for the effectual and permanent scouring of small ditches excavated through loam or clay. Large and deep ditches, made straight and so situated that they will not receive silt or debris in large quantities will usually be self-cleaning.

There are a few facts bearing upon the drainage of level lands which have been fairly well demonstrated and which, in the planning of works, should not be disregarded. One of them is that deep ditches are necessary to accomplish the desired end. By this is meant those excavated from 6 to 10 feet deep. In many instances the entire grade for lateral drainage must be made by additional depth of the outlet. The velocity and carrying capacity of the ditch increases with the depth. For example, a ditch carrying water 6 feet deep will have a mean velocity 40 per cent greater than when the water is only 2 feet deep. Water 8 feet deep will have twice the velocity of that 1 foot deep in a ditch of the same width. This partially explains why shallow ditches are such marked failures as drainage outlets. Their carrying capacity is comparatively small and their action affects only the surface of the soil.

(To Be Continued.)

THE PRIMER OF IRRIGATION.

Chapter XII.

THE USE OF WELLS, STREAMS, DITCHES AND RESERVOIRS TO DISPOSE OF THE TREMENDOUS SUPPLY OF WATER.

Statistics show that the mean annual rainfall of the world is thirty-six inches, which is about 50,000,000 cubic feet per square mile of the earth's surface per annum, a quantity of water which is amazing when reduced to gallons so as to bring it more readily within the average comprehension.

A gallon of water, United States standard, weighs eight and one-third pounds and contains 231 cubic inches. As there are 17.28 cubic inches in a cubic foot, a simple calculation will show that the annual rainfall on every tract of land equal to 640 acres amounts to 374,026,000 gallons, or, reducing it to weight, 1,558,442 tons of water, being about 2,435 tons per acre. It will, of course, be understood that all this water is not equally distributed, but it all falls upon the earth somewhere and is taken up by the soil in the same proportionate amount as by the oceans and seas. The calculation might be made more accurate by assuming that the surface of the earth is about one-third land and two-thirds water, and that, therefore, only one-third of this enormous quantity of water is taken up by the land, but we are dealing with averages and the record must stand as written.

This tremendous supply of water must be disposed of by nature in some adequate manner, for if allowed to stand and accumulate the earth would soon be submerged. Fortunately, Dame Nature disposes of it, except when an inundation somewhere sweeps away towns and country, showing that she herself is overburdened with the supply. The rain falls and is carried off the land so far as the surplus that is not drunk in by the ever-thirsty soil is concerned, by means of brooks, rivulets, streams, rivers and mighty waterways into the ocean for transformation by evaporation into more rain. A large portion of it remaining on the land also evaporates, that is, transformed into vapor, which hangs in the atmosphere, invisible except to touch, when the weather is "damp," as is said, or gathers into clouds which empty their contents back upon the earth. So far, the action of evaporation and rainfall is equal and the equilibrium or eternal balance of nature is maintained.

SURFACE WATER.

But an enormous portion of the fallen rain does not return into the atmosphere, whence it came, to repeat its beneficial and grateful performance; it penetrates into the soil, percolates through a myriad of pores, cracks and crannies, until it accumulates beneath the surface of the earth, sometimes at immense depths, and forms subterranean streams and reservoirs. Sometimes, when the soil is unyielding, the percolating water does not attain the dignity of a subterranean stream or reservoir, but is held in the grasp of the soil above some impervious or impenetrable stratum of rock or hard pan, and becomes what is known as "surface water," a water table which throws off moisture to be carried to the surface by capillary attraction.

It is a maxim in physics, "nature abhors a vacuum," and so whenever there is a vacant place the water fills it, and thus there is a never ending supply of water from rain or melting snow which is practically rain in another form. The fact that there are rainless, arid regions does not alter the fact, for somewhere beyond them in the mountains is the supply of water the rainless belt should receive, and it sinks beneath the arid lands waiting to be drawn up to the surface by the ingenuity of man, it being prevented from doing so of its own accord by insurmountable obstacles in the soil.

The method of reaching these subterranean deposits of water, underground reservoirs and water tables, is by what is commonly called "a well." When a well is dug down into the water table or surface water, say from four to six feet in diameter or any other size deemed adequate to insure a good supply of water, and from ten to 100 feet in depth, and curbed with stone or mitred plank, and a windlass and bucket arranged at the top, or a common suction pump, a certain amount of water supply is assured. For domestic purposes, perhaps to irrigate a small garden patch, where labor is of little consideration, a well with the above pumping apparatus will serve, but few farmers will rest content with this ancient system of procuring a water supply, and if anyone aspires to cultivate the soil and irrigate he must largely extend his plant.

QUANTITY OF WATER NEEDED.

To estimate the quantity of water that the irrigation farmer must provide, it is necessary to go into a few details as to the quantity required to raise a crop. That quantity he must have or go out of business.

To irrigate a few acres successfully it may be necessary to have a supply of water running up into the hundreds of thousands of gallons. Taking rainfall as the standard of water needed to grow a crop, we find that one inch of rain on an acre of ground is equivalent to 27,154 gallons, and for the purposes of irrigation, that is, to give the ground a good wetting, at least two inches of water are necessary, more being required in some localities.

Professor King has made the following estimate of the quantity of water required during the growing season in various localities:

Wisconsin	34 inches per acre
California	7½ to 20 inches per acre
Colorado	22 inches per acre
India..................	48 inches per acre
France and Italy........	50 inches per acre

To still further go into the details of the quantity of water required to grow a crop to maturity, Professor King gives the following table of amounts of water necessary to produce the certain plants dry:

	Pounds of Water to Each Pound Dry Product.
Dent corn	309
Flint corn	233
Red clover	452
Barley	392
Oats	552
Field peas	477
Potatoes	422
Rye	353

This enormous quantity of water which must be provided for the needs of plants is not an alarming amount when it is considered that it may be obtained

very cheaply by modern machinery where the water supply is adequate and a proper arrangement of ditches and reservoirs is made to economize it, the universal tendency being always toward waste.

WHERE OPEN WELLS ARE A SUCCESS.

Ordinary open wells are more successful in clay and stone than in sand, there being far less liability of the water running out, the bottom of the well being a retaining reservoir, which may be greatly enlarged by tunneling out to any safe distance into the water table or water stratum. Where the water stratum is in sand it is better to use screen points, that is, tubing with perforated ends, which admit the water but keep out the sand. Several of these screen points may be run down into the water-bearing sand stratum at a sufficient distance to prevent one robbing the other, and all be connected with a suction pipe. Experience tells that these screens should be run down to the bottom of the water-carrying sand if possible, and that in any event they should be sized according to the depth of the strata.

To accomplish this purpose successfully in wells an open well large enough for two men to work in should be sunk down to the sand and curbed to prevent caving. Then by driving ordinary gas piping as a casing for the screens and boring with a common auger, the screens may be lowered to any depth, or if the water-bearing sand is very deep a succession of screens may be put down on top of each other to enlarge the water supply.

Assuming the water supply to be adequate for the purposes of reasonable irrigation from a well, the next question is how to raise the water in the most economical manner. Economy is wealth in irrigation more than in any other business. Horace Greeley boasted that he raised the finest potatoes in the country, but they cost him about $2.50 each, and his milk cost him the same price as the finest imported champagne wine.

WINDMILL IRRIGATION.

Aside from human muscle and ox or horse-power drawing water in the ancient fashion, and still practiced in Asia, the simplest and least expensive method of raising water is by windmill. A sixteen-foot windmill connected with a storage reservoir will raise water enough to irrigate fully ten acres. But the windmill could not deliver the amount of water demanded if the supply were used at the same time as the pumping, hence the necessity of constructing a reservoir in which to store the water. With this reservoir the windmill may be made to pump constantly and provide a supply of water against the time of need. One with a capacity of several millions of gallons may be constructed without great expense, as will be described on another page.

Instead of a windmill, a centrifugal pump may be used which will raise water to a height of about fifty feet at a cost of less than 30 cents per million gallons. These pumps are geared to be operated either by steam or gasoline engines. Where there is plenty of fuel or coal is accessible, steam power is advisable, but where fuel is scarce or expensive the use of gasoline is naturally more economical.

In central Asia, which includes Persia and the surrounding countries, the water of the brooks and mountain streams seeps through the porous conglomerate formation and disappears deep in the earth, forming subterranean streams. Owing to the nature of the soil, canals and ditches would not be of much utility, and hence recourse is had to a system of irrigation by means of a group of deep wells dug at the base of the mountains. These wells are connected together by underground galleries which terminate in a large well, which answers the purpose of a reservoir. Along down the valley some distance from the large well are established a series of dry cisterns about 150 feet apart, the bottoms of which are lower than that of the well reservoir. The depth of these cisterns diminishes gradually until the last one is reached, the depth of which may not exceed eighteen inches.

All of these wells and cisterns are connected together by galleries large enough for a man to pass through in a stooping position. This arrangement of wells and cisterns with their connecting galleries is sufficient to supply an open canal which carries water to the valley, the whole length of the irrigating system ranging from two to thirty miles. Direct conduits and piping have been used, but discarded owing to the tremendous depth of the wells and the fact that the water is seepage water, not collecting fast enough to be piped. Sometimes water is run into these subterranean reservoirs and the water supply thereby augmented largely.

This system of connecting a number of wells with tunnels or galleries has been tried in the United States and has proved satisfactory in providing an increased water supply by means of an underground reservoir. Deep cisterns have also been tried for the same purpose, but the most common practice is to run a tunnel or gallery out from the bottom of a single well, in fact several of them, if the formation will permit. If sunk on high ground a flow of water may be secured from below by piping, otherwise pumping must be resorted to, which is the case when the wells are very deep.

All the rising subterranean waters are essentially artesian, whatever the depth of the bore of well which strikes the vein.

An artesian well is nothing more than one branch, end or leg of a tube or pipe, the other end, or intake, of which is at a greater or less elevation above the outlet. The fact that such wells are so called from the city of Artois, in France, where deep flowing or spouting wells were first sunk or bored, has nothing to do with the characteristics of the water supply, provided it rise in the well, flows over the mouth or spouts up into the air. In such cases it is evident that the water is not what is usually called surface, seepage or drainage water, although there is very little difference.

The value of the artesian well, which is bored deep into the earth, lies in the fact that its elevated source is constantly being replenished with a supply of water greater than that used for irrigation or other purposes. In the case of water from a saturated soil, or water that has percolated down through porous ground through cracks and crannies to find reservoirs, the supply depends upon the amount of rainfall or seepage. In ordinary wells, to draw water by constant pumping for adequate irrigation is to soon exhaust the stored supply, or ground water, there being no source to replenish it.

But in the case of artesian wells in the arid regions the source of the subterranean water which rises, flows over the mouth or spouts up into the air, is in

a region where the precipitation of water in the form of rain or snow is much greater than can be utilized, or the underlying water plane is supplied from the perennial flow of large rivers or streams fed from a never-failing watershed.

It is essential to artesian water that it be confined under pressure beneath a cover. All water in porous soils, if the pores are to be filled to saturation, must rest upon a floor of practically impervious material. Underground water has a slow motion on account of the resistance of friction, and accumulates, assuming a nearly horizontal position along its upper surface, as it does in an open pond or reservoir. This is its nature. Now, if an overlying impervious bed has an inclination steeper than the inclination of this water plane, its dip may bring it into contact with the water. Down grade from the line of meeting of the water plane with the under surface of the more steeply inclined impervious cover, the conditions of confinement under pressure exist, and beyond this line of contact or meeting the ground water will be artesian—that is, when it finds an outlet it will rise, seeking to attain the portion or level its surface would have were it not for the obstacle in the shape of the overhanging rock or impervious bed in its way.

When this impervious covering is perforated by boring a well, the question whether there will result a flowing well, or a mere rise to some higher level within the bore hole, will depend on what the level of the ground surface may be. If at that point the ground surface happens to be above the grade plane of the confined underground water, there can not be a flowing well.

TAKING WATER FROM STREAMS AND RIVERS.

There are four varieties of natural water courses, the waters of which, when used for the purpose of irrigation, require different machinery or appliances to control.

First—The slow current, to control the water of which all that is necessary is a simple sluice gate that may be opened or closed by any contrivance which can be raised or lowered or moved to and fro sideways to admit or stop the flow of water or regulate its quantity. At a point above the level of the land to be irrigated a three-sided box is sunk, the bottom of which is below the regular surface of the water and the top above the surface of the leveled bank.

The end toward the water is fitted between two uprights on each side of the box, which form grooves to permit the slide to be moved or pushed down to control the supply of water. Or, the "gate," as it is proper to call the sliding end of the box, may be in two parts hinged at each side and swinging open in the middle like the gates of a transportation canal, care being taken to have the two wings of the gate open up stream so that the pressure of the water will not throw them open automatically.

These two simple principles of an intake and shutoff gate is the basis of all contrivances for admitting water from a slow moving stream, whether the land to be irrigated consist of 100 or 1,000 acres. There are many varieties of them, some in iron and steel and constructed of massive masonry to accommodate an enormous flow of water, but all of them are substantially based upon the idea given above.

Second—Rapid current streams, or mountain torrents, require a dam to reduce the current before it enters the water gate, or else the latter would be soon torn out or undermined by the swirl of the waters. This is the object of the dam: to create a smooth, placid sheet of water, similar to the surface of a pond or reservoir, and from it admit water in through the water gate. This dam, if the current is very swift, may be constructed at right angles with the bank, that is, straight out into the stream. This will form a breakwater, a quiet harbor, so to speak, and the water wil become still inside of it.

Third—Dry rivers. Dry river beds are common everywhere in the arid and semi-arid regions. They are often alluded to as "rivers with their bottom on top," being dry nearly always except during the rainy season, when a greater or less body of water flows in their channel, according to the quantity of rainfall within reach of the watershed which supplies them.

Although surface-dry for eight or nine months of every year, there is in most cases an underground supply of water sufficient to supply an enormous quantity of water by sinking cribbed reservoirs and pumping. For the ordinary purposes of irrigation these streams must be dammed to create a reservoir which will retain the water when it flows, and back it up high enough to reach the head gates of the irrigating ditches along its banks. These streams are not always as peaceable as they seem, for they are often converted into raging torrents that carry away every obstacle in their path. Hence the damming of them requires the highest engineering skill and the most substantial material to dam up the water, for no one can tell whether the stream will run a small quantity of water or inundate the country around about.

An arroyo is the Spanish for a small cut or opening between low hills, and refers to a small stream or rivulet that sometimes flows through it. These water courses are not streams, properly speaking, but rather waterways, for they have no subterranean or underground water, and what does flow in or through them is adventitious or accidental, depending upon the quantity of rainfall.

These arroyos are quite common in all hilly land in the West and Southwest, and sometimes reach the dignity of mountain torrents, but in a few days they run dry and the water is lost. Much of this water may be saved for irrigating purposes in a variety of ways. Damming is not advisable generally, for the dry stream may become an irresistable torrent and sweep everything out of its path. A partial or wing dam in most cases will hold the water for several weeks, perhaps three months, and permit it to slowly seep down into the soil for the benefit of the land below, or, where the lay of the land on the hillsides is favorable, running deep furrows parallel with the slope will restrain the water from flowing too rapidly down the watershed, and thus also permit it to seep slowly into the soil, and if followed up will eventually result in creating a water table into which shallow wells may be sunk for pumping purposes.

Where the land is sloping below a hill or series of hills deep furrowing with a sidehill plow at intervals of say six feet from the top to the bottom of the hill with a succession of rough furrows at the bottom will save up or store enough water to irrigate by infiltration many acres of land for corn, potatoes, melons and vines generally. Experiments demonstrate that this process will equal two irrigations of an inch each, and by careful, constant cultivation a good crop of corn or potatoes, even melons, pease and beans, may be

grown without any irrigation, the subsoil being moist and kept so by deep tillage while the crop is growing.

Varieties of head gates, the direct drawing af water from rivers and streams and damming are not given, for the reason that such appliances are not within the control of the individual irrigation farmer, but are under the management of the State, the federal Government or of water companies. The idea is all that is necessary in this article, and from the idea given the farmer may apply the principle to ditches and reservoirs over which he has control on his own land.

BREEDING CANTALOUPE SEED.

Remarkable Improvement of the Colorado Rocky Ford Melon by Process of Selection.

BY PHILO B. BLINN,
Colorado Agricultural Experiment Station.

The cantaloupe now known as the Rocky Ford was originally Burpee's Netted Gem, but under the favorable conditions which prevail in the arid regions of Colorado it has developed into a melon surpassing in quality the parent stock, and its superior merits have won for it a new name and a popular reputation.

The cantaloupe is a product of years of systematic selection, and it requires the same methods to maintain its excellence as were employed in its development. Without care in selection, the natural tendency of all cultivated plants to vary will soon cause a good strain of cantaloupes to revert to an undesirable type.

There is a marked contrast between the products of carelessly selected and pedigreed, i. e., carefully selected, melon seed; the one is inclined to be irregular in size and form, with the netting thin and often wanting, and with a decided tendency to ripen prematurely, turning yellow and soft; a loss not uncommonly of 20 to 40 per cent in culls, while choice seed produces melons that are uniform in size and shape, the netting thick and complete, the marketable stage more prolonged, and practically no loss in culls.

The wide reputation of the Rocky Ford cantaloupe has created a great demand for Rocky Ford seed, as it is claimed to produce a higher grade of cantaloupes than seed from other States, and each year large quantities are saved to fill this demand, but unfortunately for the industry, the quality of this supply is not what it should be; it is principally produced from the cull piles.

After frost, at the close of the shipping season, everything in the line of a cantaloupe, green or ripe, large or small, is gathered and run through a melon seeder, with no attempt at selection.

This seed is bought by the jobber and seedsman for ten to twenty cents per pound, and when it is on the market it can not be distinguished from well selected seed, and doubtless is sold as such.

There would be nothing to commend such seed to any practical grower if he realized its source.

As the seed market has been so abused, to procure good seed one must either save it himself, or have seen the melons from which it was saved, or purchase it from a reliable grower before it has passed through several hands.

The fact that seed can be had cheap and growers are willing to plant it, is an evident reason for its existence on the market, but the lack of information as to what constitutes a good seed cantaloupe may also be responsible for poor seed selection. In this bulletin we wish to show what a good melon is and that it pays to plant and save good seed.

STANDARD OF PERFECTION.

A perfect Rocky Ford cantaloupe should be a melon slightly over four inches in diameter and about four and five-eighths inches long; it should have silver grey netting that stands out like thick, heavy lace, practically covering the entire melon, save the well-defined slate colored stripes; these should run the whole length of the melon clear cut as if grooved out with a round chisel, and terminating at the blossom end in a small button. The interstices in the netting should be light olive green, that turns slightly yellow when the melon is ready for market. A melon with a black skin under the netting is not so attractive in appearance.

But the outward appearance is not the only basis for selection in saving seed; the inside points are as essential to consider as any external quality, and no one can determine that a melon is fit for seed until it has been cut open and the inside qualities examined; for this reason the machine seeder is of no use in selecting choice seed; the melons should all be cut and examined by hand.

The flesh should be thick and firm, of a smooth texture, and free from watery appearance, rich and melting in flavor. The shipping and keeping qualities depend largely on the solidity of the melon, so the seed cavity should be small and perfectly filled with seed. The color of the flesh near the rind should be dark green, shading lighter toward the seed cavity, which should be salmon or orange in color. The flesh is often mottled with salmon, and not uncommonly the entire flesh is of that color. The flavor is usually quite uniform, though it is sometimes affected by the health of the vines or other conditions of growth.

The seed will bear close inspection, as it is sometimes cracked or sprouted, which renders it of no value for germination.

The first steps in seed selection should be made when the melons are growing. Extra prolific hills should be marked with stakes, and the earliest ripening specimens conforming to the above ideal should be saved as choice seed, and planted in a place isolated from other melons, and the same care should be exercised in the years that follow.

Unless one has a well developed strain of seed, it is not probable that he can save more than one or two pounds per acre of extra selected seed, so the supply of choice seed is limited.

The market value of the cantaloupe at the time the seed is saved should determine the price of seed. Thus, it requires about as many melons to produce one pound of seed as will fill a standard crate, and actually more, because some melons need to be rejected. This can not be fully determined until the melon is cut, when, if it proves unfit for seed, it is also lost for market. So the price of seed must be equal to or exceed the price of a crate of melons at the time the seed was saved.

At the average price of cantaloupes through the shipping season, the grower must realize at least a dollar per pound to warrant him in saving seed for the market. At the close of the shipping season, when melons are no longer marketable, the seed is willingly saved for what it will bring. This is the source of a large part of the seed on the market.

TEST YOUR LAND FOR WATER.

Remarkable Development of Pumping Irrigation in Many Sections of the Arid West.

M. C. Jackson read a paper before the National Irrigation Congress at Colorado Springs in 1902 which is of great importance as showing what can be accomplished by pumping up underflow waters to tablelands. This paper has been in great demand everywhere, and the Colorado Machinery Company, of Denver, has met these requests by publishing the article in pamphlet form. A comprehensive abstract follows:

"The importance of artificial means for bringing the increasing underflow of water to the surface to be utilized in converting wild grazing land into the most productive soil on the American continent, thereby instantly increasing its value five to ten fold, is not generally recognized as it should be. We will cite but one of many instances proving the value of individual pumping plants.

"A Weld County, Colorado, potato farmer owning 160 acres, forty-two of which were above ditch, and was valued at $15 an acre for pasture land, installed a $650 irrigating plant last May, and by the aid of this plant the net product of this forty-two acres was 28 per cent greater than the best crop raised on that portion under ditch; while the section under ditch was short of water four to ten days at the time most needed, the forty-two acres had water just when needed, and he now says this land, worth but $15 last year, could not be purchased for $150 per acre.

"The value of this important feature in irrigation will now be doubled annually since the great victory gained by the arid West in the recent irrigation act passed by the National Congress. This act provides for $8,000,000 to be used for reclaiming arid and semiarid lands of the West, this amount to be augmented largely each year by the sale of government lands in sixteen states and territories of the West. This act will attract widespread attention, increase the demand for irrigated lands of the West, where additional thousands will find prosperous homes.

"Citing my personal experience along this line, I will say that in 1881 I sunk a well sixteen miles from the foothills along which irrigation ditches ran conveying water from the mountains. This well was sunk eighteen feet deep, securing water enough to raise two feet in the well and supply a hand forcepump for irrigating one-half acre. In 1884, three years after, I noticed the water stood five feet deep in the same well, and I could not lower it with the pump. In 1890, nine years after the well was sunk, the water came within four feet of the curbing, making fourteen feet of water in the well instead of two the first year. This practical test and additional experiments strengthened my belief that as irrigation increases, spreading water over the surface of the land, that the underflow would increase proportionately. This water would eventually form waterways, seepage courses and find its way to or near the surface of the lowlands or plains, and possibly several hundred miles distant from the mountains. To prove this I have found a good supply of water in wells from ten to thirty feet by digging in the bed or near dry waterways until gravel is reached. In some cases a well from three to five feet in diameter will give a sufficient supply of water. In other instances I have sunk wells from eight to twenty feet in diameter. This, of course, depends on conditions, flow of water and amount desired. It is often the case that the underflow of these dry streams is sufficient to yield a valuable farm supply.

"In 'prospecting' for water, select a point in the stream bed where it seems to be confined by narrow banks. Where a flow has been found the amount may be largely increased by putting in a submerged dam to bedrock from bank to bank. Broken rock and cement, or rock and a good quality of clay, may be used in the construction of this stoppage dam. If you have a swamp or seepage tract of land, locate your pumping plant on it. Throw the water up on a dry, unprofitable tableland, and in this way make not only your swamp land, but your tableland, productive and valuable.

"The ownership of these individual plants is growing very rapidly, and well it may, as the happy possessor of twenty to fifty acres of good soil that he can irrigate from a pumping plant of his own is the owner of a sure, profitable and independent living. No ditch bosses, no clouds to depend upon, and expense only nominal, make him independent and thrifty. There are thousands that are even now operating or expecting to install a plant of their own, and the number of sources from which a sufficient supply of water can be obtained surprises many who have not given the subject thought. The few weeks of drouth that occurs at the very season when most needed, curtailing the supply of ditch water, has greatly stimulated the introduction of these plants, proving that forty acres well tilled will yield more profit than several hundred acres farmed in the old haphazard way.

"Quoting such authority as Mr. G. E. Mitchell, who says: 'If the underground waters of the East, South and West, which are so near the surface as to be easily raised, were used for the irrigation of the land wherever there is such a water supply, the increased production of agricultural wealth would be so vast as to be almost beyond calculation; and it would seem as though nature had planned that the waters which she has hoarded beneath the surface should never be monopolized; that this supply under the land is the surest, safest, cheapest and most unfailing source of water for countless rural homes, which those who own the land may till it with their own hands and produce from it an almost limitless diversity of crops. No vast storage reservoirs are necessary for such irrigation, no costly canals or irrigation works to bring this supply from beneath the earth up to him who would use it. This is a mine of wealth which lies under his hearthstone, and to which he can sink his own 'prospect shaft.' He needs only a well, a pump and some inexpensive power to utilize this water supply to unite it with the land and reap the increased fertility it will create.'

"Another feature I wish to call attention to: As irrigation increases and is extended, just in proportion will natural moisture and rainfall increase. This increased humidity will produce more equable temperatures, greatly reducing the danger of either drouths or excessive rainfall. I remember that twenty-five years ago dews were unknown along the eastern base of the Rocky mountain regions. At present dews are common and heavy. To prove this more fully, I quote from an authority the result of irrigation in Egypt: 'The great Egyptian Sphynx, the oldest and most colossal statue in the world, is rapidly crumbling away. It has stood for nearly sixty centuries, but now it is

vanishing at the breath of modern civilization. The great irrigation works recently carried out in Egypt have radically changed the exceedingly dry climate which made the astonishing longevity of Egyptian stone monuments possible. Under old conditions these might be expected to last practically forever, so far as weather is concerned. Now there are from fifteen to eighteen days of heavy rainfall in the year, whereas there was formerly only an hour's rain a day for a week. The increased humidity, combined with mild frost at night in winter, is rapidly disintegrating the stone of the Sphynx.'

"In conclusion, to strengthen my belief that the underflow is increasing with increased irrigation, I made tests eighty-six and 105 miles distant from the foothills, and was gratified to find that water could be had in abundance along the draws and dry waterways at from four to eight feet below the surface. I am thus convinced that each year will increase this underground flow. My early experiments were made with a view of securing water for stock on the open range and bringing it to the surface by means of windmills. The increased supply of water above mentioned led me to investigate the possibility of successfully and cheaply raising water in sufficient quantities to irrigate land for farm purposes. I made many tests with endless chain devices, spiral pumps, horse, steam and wind powers. I then installed a gasoline pumping plant, which proved very satisfactory. This was in 1883. Since then I have seen many such plants installed throughout the West with such marked success that I am now of the opinion that if care is used in selecting an up-to-date engine and pump that this is the most satisfactory and economical manner of irrigating from wells now known.

"'And the Lord said: Make this valley full of ditches.'—II Kings, iv: 16.'"

REVIVAL OF MOUNTAIN IRRIGATION.

Large Canal From the Yellowstone River Backed by Western Capitalists—Will Cost $300,000.

North Yakima, Wash., March 25.—*Editor* IRRIGATION AGE: Montana is having a revival in irrigation canal building. The new field of operations is the Yellowstone Valley. A company composed of successful business men of Billings and practical canal makers of Seattle, Wash., has begun the construction of a large enterprise. It includes the taking of a canal from the Yellowstone River, for a distance of fifty miles, to irrigate 25,000 acres. The tract is said to be one of the finest for irrigation in the State.

The proposed canal taps the Yellowstone at Laurel, about fourteen miles west of Billings. It will be forty feet wide at the top and carry water to the depth of five feet. An appropriation of 500 cubic feet per second of time has been made by the company. This will be conveyed to the land and sold to purchasers of acreage property. The duty, as defined by the canal promoters, will be one cubic foot for 100 acres. For such water right, and the land to irrigate, the company will charge $35 per acre.

The new organization is known as the Billings Land and Irrigation Company. Articles of incorporation have been filed in Washington. The principal officers are residents of Seattle. John Schram, a retired business man, is the president and W. T. Clark, a well known promoter and canal builder, is secretary and general manager. Several prominent men of Billings are also interested in the company. The project is estimated to cost about $300,000 and the managers state that they have the money to complete the work.

Lands are to be sold to actual settlers on the deferred instalment plan. This is a scheme evolved by the incorporators and has some most unique features. One new idea is that of selling land and water on seven years' time and giving the farmers an opportunity to develop the fields on less than ordinary annual rental charges. They require the purchaser to pay $10 down and leave the remainder for five to seven years. The purchase of land and water includes actual ownership of the canal when all acreage is sold.

The plan of the farmers owning and operating the canal has been worked in the Yakima Valley of Washington. Two years ago W. T. Clark, manager of the Billings scheme, constructed a twenty-seven-mile canal to carry water from the Yakima River to the Moxee Valley. The project cost over $75,000. It was completed and men were at work on the lands within three

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42 PRINTERS' INK

EDWIN F. ABELL, head of the company that publishes the Baltimore *Sun*, died in that city February 28, aged sixty-three years. His father, A. S. Abell, was the founder of the *Sun*, which dates from 1837, and the deceased was the last surviving son, having had the management of the paper for ten years past. His death was, in a measure, brought on by grief and shock following the Baltimore fire

THE *Irrigation Age*, published monthly in Chicago by the D. H. Anderson Publishing Co., has absorbed *Modern Irrigation*, Denver. There are five publications in the United States devoted to the subject of irrigation, and the *Irrigation Age* leads them in point of circulation, being credited with a monthly average of 22,100 copies for 1903 in the Roll of Honor. The consolidation gives a further increase. The Denver publication made no statement of circulation, and was credited with H—exceeding 2,250 copies. The *Irrigation Age* is nineteen years old, and is said to have readers in all parts of the world among individual irrigators and irrigation corporations.

THE Hackstaff A
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THE cir edition of i increased t past year, i no change advertising

A BILL legislatur compel p facturers on all bo for sale ure ori medical This is Mansfiel sented i a law i do not druggis the fact their bu medicines popularity who are patent medi to use them to ask the ties of othe proprietar in the the

We are reproducing herewith notice which appeared in the columns of PRINTER'S INK, the leading authority in the advertising field, for which we wish to thank the publishers of that journal and at the same time call attention to the fact that the combined circulation of the two journals is considerably more than the figure named.

months. Lands were sold for $60 an acre, including water right and ownership of the canal. Colonists purchased all the lands before the canal was finished. After two years the same lands are selling for $150 to $300 per acre.

It is understood that an active campaign will be opened by the new canal builders for colonizing the Yellowstone Valley. The country is one of the chosen irrigated districts of Montana. It is crossed by the Northern Pacific and Chicago, Burlington & Quincy railroads. There are several prosperous farmers engaged in growing alfalfa, cereals and potatoes in the county. The altitude is about 3,000 feet above sea level and the valley is one of the Rocky Mountain eastern slope fields in which irrigation has worked wonders in growing vegetation.

JOEL SHOMAKER.

NATURE'S METHOD OF PRUNING.

Gifford Pinchot Describes the Process by Which Trees Shed Dead Branches, But Does Not Tell All.

While the trees are pushing up most rapidly, the side branches are most quickly overshaded, and the process of natural pruning goes on with the greatest vigor. Natural pruning is the reason why old trees in a dense forest have only a small crown high in the air, and why their tall trunks are clear of branches to such a height from the ground. The trunks of trees grown in the open, where even the lower limbs have abundance of light, are branched either quite to the ground or to within a short distance of it. But in the forest not only are the lower side branches continually dying for want of light, but the tree rids itself of them after they are dead and so frees its trunk from them entirely. When a branch dies the annual layer of new wood is no longer deposited upon it. Consequently the dead branch, where it is inserted in the tree, makes a little hole in the first coat of living tissue formed over the live wood after its death. The edges of this hole make a sort of collar about the base of the dead branch, and as a new layer is added each year they press it more and more tightly. So strong does this compression of the living wood become that at last what remains of the dead tissue has so little strength that the branch is broken off by a storm or even falls of its own weight. Then in a short time, if all goes well, the hole closes, and after awhile little or no exterior trace of it remains. Knots, such as those which are found in boards, are the marks left in the trunk by branches which have disappeared. GIFFORD PINCHOT.

Mr. Pinchot, in the above beautiful description, explains the process of pruning followed by nature. Although he neglects to inform the public, whom he wishes to instruct, how long a time must elapse before this operation can be completed, or what an expensive operation this becomes through nature's methods.

When owners of timber land leave entirely to nature the work of pruning they must, of necessity, await Dame Nature's pleasure as to when she will perform the operation. Meantime interest and taxes accumulate and multiply, old age advances more rapidly than the trees can increase in size and the investment becomes of great duration, for trees can not make rapid progress while in the crowded condition in which they exist as Nature usually scatters her seed.

The procedure is beautiful, but it does not increase the bank account of the waiting investor.

Besides, there are certain trees which do not shed their branches after they have been killed by shade.

In these the new wood growth each year incloses the dead branch, and in time disease germs enter the tree through this channel of a decaying member, being conveyed by water and the atmosphere, when the tree becomes a hollow, worthless trunk.

And, further, many species of trees form an upright stem without overcrowding.

The old theory of crowding young forests will never succeed under American impatience for results. —*Arboriculture.*

1903 Irrigator.

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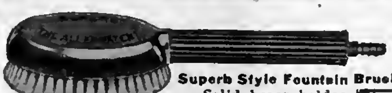

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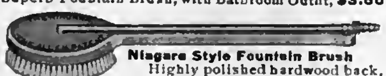

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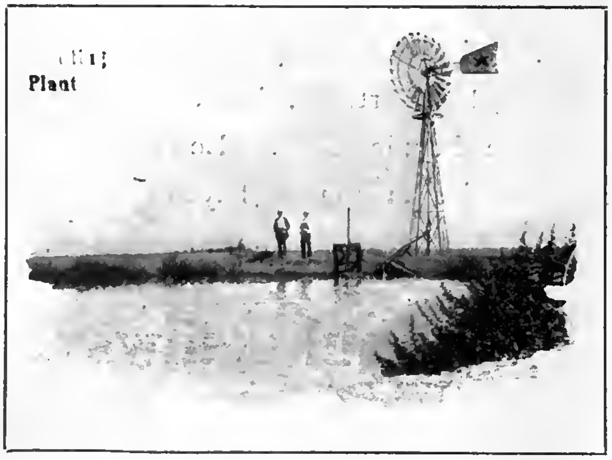

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VOL. XIX. No. 7.

THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

MAY, 1904.

THE D.H. ANDERSON PUBLISHING CO.,
Publishers.
112 DEARBORN ST.,
CHICAGO.

TEN CENTS A COPY
ONE DOLLAR A YEAR

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ESTABLISHED 1885
WITH WHICH IS MERGED
THE DRAINAGE JOURNAL
ESTABLISHED 1879

SPECIAL FEATURES

CHARLES A. COX CHGO.

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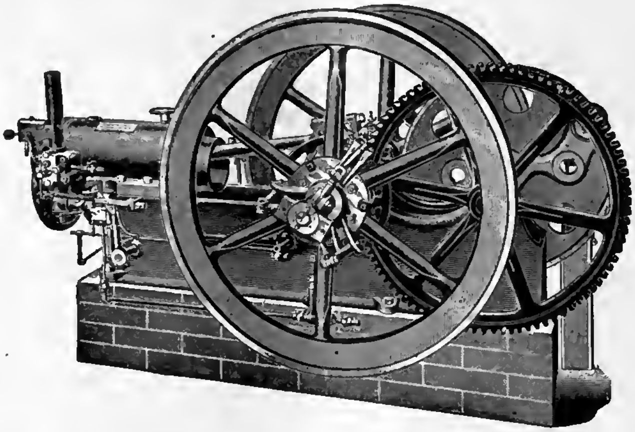

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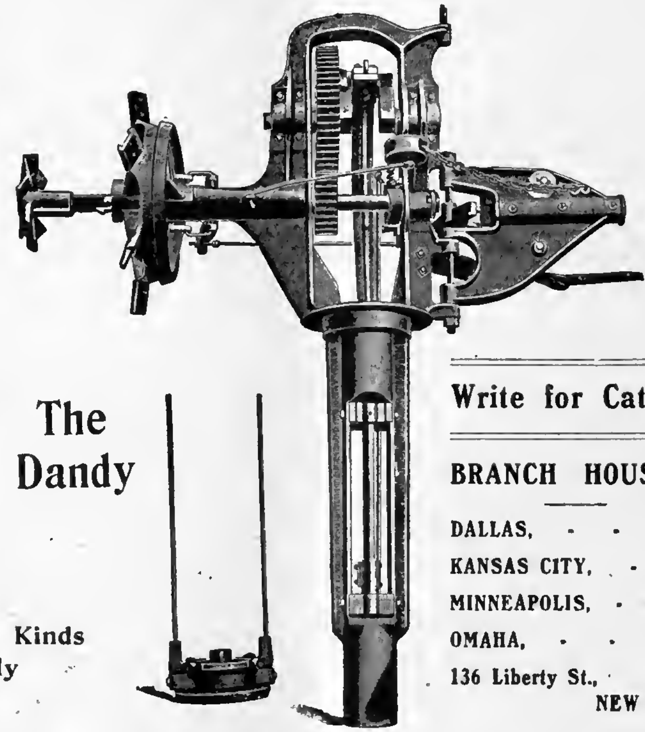

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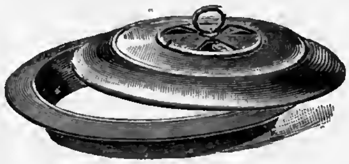
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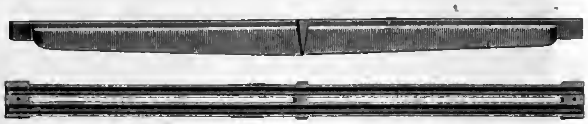

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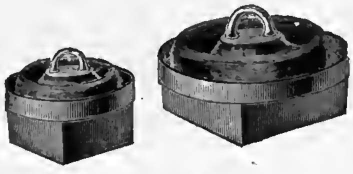
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THE IRRIGATION AGE

VOL. XIX CHICAGO, MAY, 1904. NO. 7

THE IRRIGATION AGE
THE D. H. ANDERSON PUBLISHING CO.,
PUBLISHERS,
112 Dearborn Street, - - CHICAGO

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W. J. ANDERSON } Editors

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GEO. W. WAGNER, Mgr. W. C. JACKSON, Editor, Western Dept.

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EDITORIAL

Lieu Land Scrip and the Land Laws.

While a great deal of discussion is taking place in the newspapers and elsewhere concerning the subject of the possibility of a scandal along irrigation lines, wherein numerous heads of departments, as well as the head of the so-called National Irrigation Association, a purely one-man organization, are likely to become implicated, it is well to consider some specific charges and movements made by the above named gentlemen. It is well understood that some time in 1900 or 1901, when what was known as the Forest Reserve Act was passed, the intention of the two legislative bodies, as well as the President, was for the preservation of all forests with a view to protecting the water sheds and stopping the wholesale taking over of fine timber tracts by individuals for personal gain. When the Forest Reserve Act was passed it developed that in taking over these large areas by the Government, certain small tracts in some of them were held by private individuals, who had secured the patent, or title, to same from the Government under the Homestead Act, commutation clause, or the Timber and Stone Act, and it was decided, if we understand the case correctly, that these individuals, whose lands would be taken over as part of large tracts or bodies, were to have the right of entry on any unoccupied Government land for an equal number of acres. This was a reasonable enough arrangement and would have worked out all right, had it not been for the fact that large corporations, whose numerous holdings were turned in to the Government under this act (and by the way, thousands and thousands of acres of this land turned back by the railways under the Forest Reserve Act were practically worthless lands), took it upon themselves to turn over to the Government large tracts of land, taking in return what is known as lieu land scrip, or scrip applicable for entry upon any unoccupied Government lands. This lieu land scrip was subsequently disposed of in large blocks by the corporations to speculators in paper of that class, who in turn disposed of it to others at an advanced price and in many instances the scrip eventually came into the hands of individuals engaged in the lumber industry, many of whom entered the scrip on different tracts throughout the West and Northwest and will no doubt secure good lands through their investments.

It is not our intention to discuss at length the advisability of the original plan of allowing the railways to turn in large tracts, for which they received scrip in lieu. Referring, however, to the act of Congress, or the several acts pertaining to the location of scrip and its relation under the Timber and Stone Act, or any other entry upon Government lands, the Government owns these lands and when it sells to the individual, it seems that it is legally bound to protect that individual in his rights. To illustrate this more clearly the Forest Reserve was brought about by proclamation

of the President, was acted upon by Congress and the United States Senate, who confirmed the setting aside of land included within the limits of any specified territory. As an illustration, we will take a tract of land set aside as a forest reserve in the State of California. This reserve was duly set aside in 1903 and confirmed by Congress and the Senate in 1904. As to the basis of the scrip, which was issued on this forest reserve, we will say that John Doe owned four forties in a section of that reserve. He had United States patent on same and had been residing on the land for a number of years. When this was confirmed as a forest reserve, the law gave Doe the privilege and right (and this right was confirmed by the Act of Congress and the Senate, signed by the President) to sell his four forties to the United States Government. He gave the United States Government a warranty deed with abstract, showing his title to be clear for the four forties. The taxes were all paid, etc., etc. The Government gave to him in return that which is mentioned above and is commonly known as Forest Reserve scrip. This scrip is filled out in blank and he is permitted to select four forties from any vacant Government land in the United States in lieu of the four forties which he transferred by title to the United States Government. To continue, we will say that one Crowe, of Portland, Ore., who is acquainted with this transfer, writes to Doe and states he will give him $5.00 per acre for his four forties inside of forest reserve lines. Doe accepts the proposition and executes a deed to Crowe, furnishes abstract showing taxes are all paid and the land free from all incumbrances and also gives Crowe power of attorney to locate four forties in lieu of this land which he has relinquished to the Government. Crowe is also given power of attorney in blank to sell said four forties. This is properly filled out with witnesses before a notary public, or clerk, in whatever State the transaction takes place. Crowe, however, does not make direct entry on the land, but he has paid Doe $5.00 per acre for right of entry on this quarter section.

Crowe, being a speculator in this class of paper, now sells this scrip, which is known on the market as Forest Reserve Scrip, to another individual in Wausau, Wis. Subsequently the Wausau man sells to the fourth man. and he, who may or may not be a timber man, locates four forties of vacant land in the State of Wisconsin or Minnesota and, having taken over the power of attorney has it properly filled in, in which it is described as an entry in lieu of that quarter section forest reserve tract. After this transaction, this is now described as Located Forest Reserve Scrip. The papers are all forwarded to Washington and after being accepted by the Secretary of the Interior and the Commissioner of the General Land Office, a patent is in due time issued for same.

This explanation is made to illustrate the difference between what is known as marketable scrip and scrip that is actually located. It is the impression of the writer that if any action should be taken by the Government to stop the location of this lieu land scrip it would be an injustice to the purchaser of the third or fourth class, who is paying a price, which has gradually increased since the time transfer was made by Doe to Crowe, and it appears that this would be an injustice to the buyer who took it over with the ultimate idea of locating it upon other lands. It is claimed that the Government has no right to pass an act cancelling the entry on this piece of land after filing has been made. It appears that Congress has no right to repudiate its obligations and perform an injustice to the holder of the scrip, no matter how many removed from the original fee holder in the forest reserve. It is maintained furthermore that if the Government has set aside any forest reserves and has given Doe the privilege to sell his land to the United States Government and then grants him in lieu the privilege to select four forties of any unoccupied lands, it should also give him the privilege of disposing of it as he sees fit and protect the individuals who purchase from him as well as any subsequent transactions of a like character.

There is no doubt but that no more forest reserve land should be set aside and no more scrip issued, but The Irrigation Age contends that all scrip which has been issued and duly entered should be fully protected; the present holder should be protected as well as the man who took the original title to the land from the United States Government.

It is, moreover, the impression of the writer that the forest reserves that have been set aside in Arizona and Washington were manipulated with the sole view and purpose of the relinquishment of land of no value, for which scrip was issued, which is now, and will later be applied for entry on any valuable lands in the United States. This plan is not the best for irrigation development, nor for the general agricultural advancement of the country; but on the contrary has been carried out to the direct benefit of large holders of railroad lands. Some tracts on the mountain tops above the timber line, beyond any agricultural possibilities, such as land on Mt. Ranier in Washington, was set aside as a forest reserve and lieu land scrip has been issued for same, so that the receivers of the scrip could secure possession of valuable lands in the public domain, which rightfully belongs to the people. Another peculiar and exasperating feature of this sort of manipulation is that the Government does not receive a dollar for the millions of acres which have been entered by scrip in this manner. It is worthy of note that it does, however, receive $2.50 per acre for every acre entered under the Timber and Stone Act and $1.25 per acre for all land entered under the commu-

tation clause of the Homestead Act. This price, $1.25, under the commutation clause, applies to land which is outside of the railroad land-grant zone. When this land is entered inside the railroad grant limits, the price paid the Government is $2.50 per acre, and this seems a reasonable and fair arrangement and is directly beneficial to the people. We therefore contend that these laws should stand as they are.

In all lands entered during the past year some 23,000,000 acres, there were only in the neighborhood of 2,000,000 acres entered under the Timber and Stone Act and the commutation clause of the Homestead Act, for which the Government received $2.50 per acre for all entered under the Timber and Stone Act, and from $1.25 to $2.50 for every acre entered under the commutation clause of the Homestead Act, $1.25 being paid for that which was located outside of the railroad land grant limits and $2.50 per acre for that entered within their limits on alternate sections to that which is owned by corporations. The remainder, about 20,000,000 acres was entered by the class of Forest Reserve Scrip mentioned above with some other scrip entries of a different character. It is a notable fact that the Government has not received a dollar in return for all this 20,000,000 acre entry; in fact has not even received enough to pay for the extra help needed in the different land offices to make out the necessary papers of transfer.

Let the people and Congress and the Senate look carefully into the above subject and decide which will result in the greatest good for the country. It is a simple proposition and worthy the consideration of every citizen of the United States.

Canal and Stream Measurements. In our issue of June will appear a paper on "Canal and Stream Measurements," written by A. P. Stover, assistant in irrigation investigations, United States Department of Agriculture, which will prove interesting to all our readers.

Irrigation Age Vindicated. In view of the recent expose of the Maxwell clique before the House Committee on Arid Lands, we feel justified in calling attention to our statement in an issue early last year under the title, "Influences in the National Irrigation Program," concerning the co-operation of George H. Maxwell with certain Government officials. In that article we said: "Before the plan submitted to the railroads by Mr. Maxwell was accepted he had the campaign fairly well outlined in his mind. He saw that it would be necessary for him to become intimate with Government officials who could bring him into contact with congressmen, members of the cabinet, and even the President." This was all brought about subsequently and had Maxwell shown any generalship, or ordinary business judgment, he could have been in a position to call on these people for support. He has, however, shown a woeful lack of generalship and is now at outs with F. H. Newell, of the reclamation service, and criticises that gentleman in his recent publications. He also intimates that President Roosevelt should not have taken the stand he has on certain pet measures advocated by himself and his employers.

It is only a matter of time when this man will step down and out without friends or sympathy. It is stated in some quarters that Maxwell is also out with Gifford Pinchot, chief forester of the United States. If so, this is a very fortunate turn of affairs for Mr. Pinchot, as both himself and Mr. Newell have been badly scorched in their contact with Maxwell. As to the effect the contact has had on Mr. Walcott, of the Geological Survey, it is difficult to state, although it is a well known fact that smoke and fire make very little impression on certain substances. At any rate The Age has been vindicated in all its charges and can but feel that it has had a very wholesome influence within the past two years. It has received congratulatory letters from its friends throughout the country, all of which are very gratifying and for which the editor wishes through this sources to express his thanks.

Senator Hansbrough's forest reserve bill, reported from his Committee on Public Lands, inaugurates a new policy relative to a question of very great importance. The bill is intended to put an end to forest reserve selection rights, frequently referred to as forest reserve scrip, through speculation in and the use of which many frauds have been perpetrated against the Government. Indeed, if the $50,000 syndicate which has been devoting itself to the repeal of all of our general land laws had centered itself upon the reform contained in this bill it would have performed a public service. It is a strange coincidence, however, that most of the contributors toward the Maxwell $50,000 fund for "educational work" in behalf of wholesale land law repeal are the ones who have been the beneficiaries under the Government's forest reserve scrip policy.

The bill provides that entrymen within forest reserves hereafter created may accept a cash settlement for all their right and interest. There will be no more scrip for the speculators, and we predict that, in consequence of this change, there will be fewer entrymen in forest reserves.

The bill further provides that as to relinquishments hereafter made in existing reserves, the exchange lands taken shall be of like character and quality both as to soil, timber, etc., and that no timber land shall be given in exchange for land denuded of its timber. This is just and wise.

THE SECRETARY OF AGRICULTURE.

Secretary Wilson.

In a chat between Secretary of Agriculture Wilson and the editor of THE IRRIGATION AGE recently, the subject of irrigation laws was touched upon, and the Secretary stated that he had been an advocate of these laws because it would give homes to a class of young western farmers who have been crossing the border into British possessions. He said that this class of farmers know everything to be known about settling up a new country and are ready to take advantage of all natural and artificial facilities; that they understood sub-district, township, county and state government and would become leaders and directors of the neighborhood fortunate enough to secure them, and that such young men and women are necessary in all settlements of immigrants coming into the United States. The idea of Secretary Wilson apparently is that the young, progressive American farmers among distinct foreign settlements, such as have been established in recent years in our western States, would have a tendency to inculcate in the minds of these immigrants some conception of American government and interests and would gradually wean them away from their foreign methods, thereby making them better citizens at an earlier date than would be possible were they left by themselves, to develop, oftentimes, along wrong lines.

Continuing further, the Secretary stated that the moment you put water on lands in arid sections you can grow the finest beets in the world, containing a higher percentage of sugar in the beet than the Europeans have ever developed. He stated that his department had sent out men to superintend the growing of beet seed in Washington, where there is 19 per cent of sugar in the beet. Continuing along the line of thought, which is apparently deeply imbedded in the mind of Secretary Wilson, he said that the young men, of whom he spoke earlier in the conversation, understand live stock, dairying, etc. They are the sons of farmers in the Mississippi valley and they can utilize all the products of beets. That is why he wants to see them out in the West, where beet culture is developing into so large an industry.

Secretary Wilson said that his department had sent out to the Upper Volga River, Russia and Algeria in Africa, for seed wheat to introduce into States where the rainfall is only ten inches, with the idea of developing macaroni wheat interest in those territories, and that last year 10,000,000 bushels of this wheat were grown and next year the crop will probably reach 25,000,000 bushels. Continuing, he said that where seed of this kind was introduced, it was first sent to the experiment stations in the different western States, where its cultivation was brought to perfection, in given localities, after which it is given to the progressive farmer and whenever its culture is fully understood the department defer further experiments along that line in that district; the Government continues, however, to experiment and demonstrate what can be done until a sufficient number of farmers in any locality are so thoroughly posted they can go on and develop crops along the lines suggested by the stations.

SENATOR HANSBROUGH'S VIEWS ON REPEAL BILL.

A representative of THE AGE recently requested Senator Hansbrough, who is the author of the national irrigation bill and is now endeavoring to put through Congress some very important measures bearing on public land questions, to give this publication his views with respect to the bill which he passed through the Senate a few weeks ago repealing the Timber and Stone Act. The Senator's reply to our request is as follows:

"Responding to your request that I furnish you with my views on the bill to repeal the Timber and Stone Act and to provide for the disposal of timber on public lands outside of forest reserves, permit me to say that the existing law is unsuited to present conditions; that it has been the instrument through which much valuable timber land has passed into private hands at a price far below its real value, and there is no reason why the Government should part with its property at figures admittedly below what it is worth.

"To repeal the law, however, without substituting in its stead a statute authorizing the disposal of timber would not be in accord with good business principles. The effect would be to force the ultimate suspension of many small sawmill enterprises, and further to create a scarcity of lumber, thus contributing toward those larger manufacturers who own extensive bodies of timber. It was for this reason that those who favored the bill which has passed the Senate agreed to the repeal of the law and the insertion of the provision authorizing the sale of the right to cut government timber in such quantities and under such restrictions as the Secretary of the Interior should prescribe.

"If the bill becomes a law the Secretary may dispose of the right to cut in such manner as will meet the demands of the mill men and the public. He will doubtless restrict the cutting to the matured trees, leaving the younger ones for future disposition. In this way perpetual forests will be preserved, which will be of lasting advantage to all. Had such a policy been entered upon twenty-five years ago the Government would be richer by a hundred million dollars, and many river beds now almost dry would be filled with water. The law as it now stands is a constant temptation to evasion and a most convenient vehicle for rapacity."

W. H. KILLEN.

We are showing herewith a snapshot of Mr. W. H. Killen, land commissioner of the Wisconsin Central railway, as he appeared at the Wisconsin State Fair, where he had on exhibition a new idea in wind mills for pumping and power work. An illustrated article will appear in a future issue of this journal concerning this mill.

U. S. SENATOR FRANCIS E. WARREN OF WYOMING.

Francis Emroy Warren was born in Hinsdale, Mass., June 20, 1844. His father was Joseph S. Warren, a member of the family of Warren—early settlers of Massachusetts, among whom was General Joseph Warren. who died at Bunker Hill. His mother was Cynthia E. Abbott, whose family came over from England with the early settlers of Massachusetts.

The father of Francis E. Warren was a farmer and trader. While liberal in many respects, he believed that a common school education, such as he himself possessed, was sufficient; and he encouraged his children to master the details of farm life in preference to obtaining education designed to fit them for the professions. Consequently young Warren's schooling from the time he was eight years old until he was fifteen was confined to a few weeks in the middle of each winter, the remainder of his time being employed in doing chores and such other work as a farmer's boy has to do about a farm. His education, as far as school life goes, was completed with about a year's attendance at the Hinsdale Academy, after which, at the age of sixteen, he was placed in charge of a dairy farm where a number of workmen were employed.

FRANCIS E. WARREN, U. S. SENATOR, WYOMING.

At the age of seventeen young Warren enlisted as a private soldier in Company C, 49th Massachusetts Volunteer Infantry. This regiment was placed in camps of instruction and drilled at Pittsfield and Worcester, Mass., was on duty in New York City, and from there was sent to New Orleans and assigned to the 19th Army Corps. It took part in the siege and capture of Port Hudson, and was in the fights at Plain's Store and Donaldsonville. When before Port Hudson the regiment was called upon to furnish a few men from each company to perform the dangerous undertaking of preceding the main force with fascines to fill a ditch forming part of the protective earth works of Port Hudson, so that the artillery and infantry might cross in a proposed assault upon the enemy's position. Corporal Warren—for he had been promoted to that rank—was one of the volunteers for the service. The colonel, and, in fact, every commissioned officer in the "forlorn hope," so-called, was killed, and about three-fourths of the men were either killed or wounded. In the assault Corporal Warren was knocked down, the fascine he carried being struck by a cannon ball, and he lay for some hours unconscious upon the battle field. Congress, later, recognized the bravery of those who participated in this affair, awarding to the survivors medals of honor.

After the close of the Civil War Corporal Warren returned to Massachusetts, where he remained until 1868 in charge of a large farming and stock-raising establishment. Then he went west and worked for a short time as foreman in charge of construction work on the line of the Chicago, Rock Island & Pacific railway in Iowa; and in June, 1868, he reached Cheyenne, where he has since resided. During his residence in Cheyenne he has been engaged continuously in mercantile and live stock business. In 1871 he became a member of the mercantile firm of Converse & Warren. Later he purchased his partner's interest, and continued the business as F. E. Warren & Co., this firm several years later being organized into a corporation termed the F. E. Warren Mercantile Company, of which Mr. Warren is now president.

He was a member of the territorial council, serving as president; was treasurer of the territory of Wyoming six years; and was territorial governor from March, 1885, to December, 1886, and from March, 1899, until the admission of Wyoming to statehood, in 1890, when he was elected first governor of the State. He was elected to the United States Senate November 18, 1890, serving until the expiration of that term, March 3, 1893, was re-elected January 23, 1895, and again re-elected January 22, 1901. His term of service will expire March 3, 1907.

THE SIDON CANAL—WYOMING.

CLARENCE T. JOHNSTON,
State Engineer.

As illustrative of the value of the Carey Act the Sidon canal in Big Horn County, Wyo., is the model as far as this State is concerned. Under no other national statute can a company, association or individual safely proceed with expensive canal construction. It is often asked why not operate under the provisions of the Desert Land Act? The reply is readily furnished by those who have undertaken the building of canals for the irrigation of lands obtained by others who have no financial interest in the undertaking. If it were possible to compel all filings on the tract to be irrigated to be under the Desert Act and require the entrymen to show that they have an interest in the irrigation works projected before title passes, the problem would be simple. The Government, however, never deals with those who are trying to develop any particular section, but with the individual entryman. He may take up land under the Desert Land Act, the Homestead Act or the Timber and Stone Act. To prove up on his desert claim he may plow a few furrows from the stream, and as there is but little possibility of an inspection by the Government, he generally feels that he is safe in making the necessary final affidavits relative to reclamation.

OUTLINE VIEW OF SIDON CANAL, WYOMING.

In many sections of the West as soon as surveyors appear on a tract of land entrymen begin to flock in and before the irrigation system is completed the land is all taken up. Probably not a single entryman desires to cultivate his land, but hopes to dispose of it at a profit, knowing that the construction of the canals greatly enhances values. Those who have invested their money are in a condition comparable to that of a railroad company that completes its lines only to find that there is no passenger or freight traffic. The people of the West have long understood this difficulty and the Carey Act was passed as a remedy. It is a remedy, but its operation has been difficult owing to the intricate working of the law as prescribed by the Interior Department. Before an application for segregation can be approved by the Secretary of the Interior, maps, field notes, land lists, affidavits of aridity, records of water supply and all kinds of miscellaneous information has to be brought before him. Sometimes a clerk forgets about an application and holds it for three or four years. Projects have failed owing to this delay. The money is secured and the parties interested are ready for work, but the segregation is delayed, and those desiring to invest become discouraged. The provisions of the law are fairly well understood, but the rulings of the Interior Department will probably never be. The law requires certain information to be laid before the Secretary of the Interior. When the approval of the authorities at Washington is secured the lands are conditionally ceded to the State. The irrigation company is protected by the refusal of the State to allow anyone to settle or gain a title to the lands until they show that they possess an interest in the irrigation works. The State also fixes the maximum rate per acre at which this interest in the irrigation works is sold. The lands themselves are sold to the settler at fifty cents per acre. The cost of the irrigation works runs from $10.00 to $30.00 per acre, depending upon the difficulties encountered in construction.

S'DON CANAL, WYOMING. VIEW 1, HEADGATE.

SIDON CANAL, WYOMING. VIEW 2, ROCK WORK.

One of the great values of the Carey Act is that it

enables an association of farmers to secure irrigable lands in tracts of not more than 160 acres to each entryman, for fifty cents per acre and the actual cost of building the irrigation works, providing this is done by those intending to settle the tract covered by the

THE SIDON CANAL, WYOMING. VIEW 3, LOOKING UPSTREAM, TWO AND A HALF MILES BELOW HEADGATE.

canal line. This feature alone is sufficient argument for maintaining the act in force.

The Sidon canal is located fifteen miles from the northern boundary of Wyoming and seventy-five miles due east of the Yellowstone Park. It is supplied from the Shoshone River, a stream nearly as large as the North Platte River at flood, and furnishing more water than the Platte during the summer season. The canal was undertaken in 1901 by a colony of Mormons, who, coming from Utah, were acquainted with some of the best canal systems in the West. They entered the Shoshone valley supplied only with their wagons, domestic

SIDON CANAL, WYOMING. VIEW 4, TUNNEL.

animals, household furniture and, instead of money, they possessed energy and courage. At about the same time the Burlington railroad began a spur running from Tuluca Junction in Montana to Cody along the Shohone above the proposed Sidon canal. The people secured contracts on this work and earned enough in this way to complete the canal by the spring of 1903. A considerable portion of the line was finished by 1902 and some land was irrigated that season. By the summer of 1903 much more had been accomplished. Two enterprising towns had sprung up on the sage brush plains and these were surrounded by green fields of alfalfa, oats and other crops.

The entire tract is located on the north side of Shoshone River. The canal is twenty-five feet wide on top, fifteen feet wide on the bottom and five feet deep at the headgate. Its grade is two feet per mile. The area of the lands included in the application for segregation is 20,000 acres. The canal is now thirty miles long and is said to have cost about $100,000. Flumes have not been employed except where they have been absolutely necessary. Wherever possible dams have been thrown across ravines and wastegates have been put in the bank of the canal to carry off such flood water as might otherwise injure the work. Some three miles below the headgate the canal skirts the base of a sandstone cliff where it was necessary to build up the lower bank by washing sand and such other mate-

SIDON CANAL, WYOMING. VIEW UPSTREAM FROM POINT ONE-HALF MILE BELOW HEADGATE.

rial as could be obtained a few hundred feet further up the canal. Water was turned in the canal for this purpose and the banks at this section are apparently as safe and satisfactory as could be desired. Where the canal first touches the irrigable bench lands a cut through cobble stones was necessary and this proved to be one of the most serious obstacles with which the people had to contend. Further on a tunnel 900 feet long carries the water through a standstone ridge, and before Sage Creek is reached considerable rock was encountered. The map and photographs illustrate some of the features of the canal.

The lands were formerly covered by a salt sage. During 1903 much of the area was not plowed before crops were planted. A disc harrow was employed and the grain sowed broadcast and harrowed in. Fields of from fifty to seventy-five bushels of oats per acre were reported during the fall. Garden products thrive in an astonishing manner. It is only a question of a few years when beet sugar factories will flourish along the Shoshone. The great Government project lies immediately to the west. This promises to reclaim over 100,000 acres of land which lies in one body.

The results accomplished under the Sidon canal

indicate what can be done by co-operation under the provisions of the Carey Act. If there is a better way for the Government to dispose of its desert lands the procedure has yet to be defined by law. The Carey Act is limited and its operation is temporary. There is no reason why this should be so. Congress ceded 1,000,000 acres to each arid State under certain conditions and then restricted the time in which canals and other irrigation works might be constructed. There is a question as to whether the act does not expire as far as new projects are concerned on the 16th of next August. It is difficult to understand the reason for curtailing the development that might be possible under this law by these restrictions. But few companies and fewer individuals care to undertake the construction of expensive works when the time for complete irrigation and reclamation is fixed at a date that makes the accomplishment of the task almost impossible. The lands not reclaimed at the expiration of this time revert to the Government and the investor is the loser. This is by far the law best adapted to the needs of the arid region. It is the one that is liable to fail first. The Desert Land Act is next in value and it has been threatened for the past four years. If both should be repealed or become inoperative, practically no great development can take place under private enterprise.

SIDON CANAL, WYOMING. VIEW LOOKING UPSTREAM, ONE-HALF MILE BELOW HEADGATE.

Raymond F. Walter, of the U. S. Geological Survey, expects to establish six stations in the western part of South Dakota for the purpose of determining the amount of water available for irrigation purposes. One of these will be on the Belle Fourche river, on Redwater creek, one on Spearfish creek, one on the Cheyenne river, near Edgmont, and two others, the location of which has not been decided upon. After ascertaining the amount of water available for irrigating, which would include the rainfall, Mr. Walter will turn his attention to the location of natural reservoir sites, some twelve or fifteen of which have been petitioned for by residents of the region. He will determine whether or not they are practicable for conserving the flood water for irrigation purposes, with particular attention to the expanse of tillable land tributary, onto which water may be carried by ditches from the proposed reservoirs.

IRRIGATION EXPERIMENTS IN ARIZONA.

Investigations Covering a Period of Four Years at the Experiment Station Farm at Tucson.

BY PROF. ALFRED J. M'CLATCHIE,
Agriculturist and Horticulturist of the Arizona Agricultural Experiment Station.

[CONTINUED.]

METHOD OF MEASURING WATER.

For measuring flowing water two different units of measurment are in use: the miner's inch and the second-foot. The miner's inch is supposed to be the amount of water flowing through an opening an inch square, under certain conditions. In most regions where the unit is used, the opening is supposed to be so placed that there will be a certain depth of water above it, causing some pressure. The required depth of water above the aperture varies in different regions from four to six inches, while in some localities the aperture is not required to be below the surface of the water from which the stream is flowing. There being a lack of uniformity in the conditions under which a miner's inch is measured, the amount of water expressed by the term is plainly not a definite quantity. Moreover, without a complicated device, it is impracticable to control the depth of water above the opening; and consequently a miner's inch of water could not be easily accurately measured out, even if the required conditions were the same in all localities.

The second-foot is a much more convenient unit of measurement, and is the one that is becoming generally adopted for the measurement of irrigating water. A second-foot is the flow of a cubic foot of water during each second of time. Thus, a second-foot flow of water for one minute would equal just sixty cubic feet, a second-foot flow for an hour just 3,600 cubic feet of water, and so on. Since the second-foot is always a definite flow of water, a second-foot flow for any definite period will equal a definite number of cubic feet of water. It thus becomes easy to compute how much irrigating water will flow upon a given piece of land in a given time. Since there are 43,560 square feet in an acre of land, it will take 43,560 seconds, or 12.1 hours, for a second-foot flow to cover an acre with water to the depth of a foot. Enough water to cover an acre a foot deep is termed an acre-foot. The flow of one second-foot for 12.1 hours, or of one-half a second-foot for 24.2 hours (twenty-four hours and twelve minutes) therefore equals an acre-foot. A second-foot flow for twenty-four hours so nearly equals two acre-feet (enough water to cover one acre two feet deep, or two acres one foot deep) that in making computations on farms it may be considered as equaling that amount, without the error being great enough to cause the arrival at serious misleading conclusions; and in most cases the error would not be greater than the errors likely to occur in making the measurements of the stream from which the computations were made. In this region an "inch" is now considered to be one-fortieth of a second-foot, the latter thus equaling forty local "inches." In making computations, a second-foot and forty "inches" may be used interchangeably, therefor.

To ascertain the number of second-feet flowing in a ditch or other channel, it is necessary to determine the size of the stream (the area of its cross-section) and its velocity. The area of the cross-section (the

product of the depth in feet and the width of the stream in feet) multiplied by the velocity in feet per second will equal the number of second-feet. For example, if the area of the cross-section of the stream be two square feet, and the velocity one foot per second, the flow of the stream would be two second-feet; or, if the area were the same and the velocity three feet per second, the flow would be six second-feet.

In ditches with earthen (and consequently more or less irregular) walls the area of the cross-section is obtained by multiplying the average depth by the average width. The placing of a flume in a ditch or other channel makes the shape of the stream flowing through it regular in that part of it, and thus furnishes a more convenient place for ascertaining the area of the cross-section. If the flume be made a certain width—as two feet, four feet, or eight feet—only the depth of the water need be ascertained in making computations.

The velocity of a stream is ascertained with more difficulty than is the size of it. By means of a float the velocity of the surface may be ascertained quite accurately, and from this the velocity of the stream as a whole estimated. For example, if a float be 40 seconds in passing between two points 100 feet apart, the surface velocity would be 2½ feet per second. But the surface of a stream moves faster than the parts of it that come in contact with the bottom and sides; hence the velocity of the whole stream is less than that of the surface,—how much less depending upon the nature of its walls. For obtaining the approximate flow of a stream, the velocity of the stream may be considered as .8 of the surface velocity. Thus, if the surface velocity be 2½ feet per second, the velocity of the stream as a whole may be considered as 2 feet per second.

A more accurate means of obtaining the velocity of a stream is furnished by the instrument known as the current meter. By its use the velocity of all parts of a stream may be quite accurately ascertained, and from these data the velocity of the stream as a whole calculated.

The necessity of obtaining the velocity of a stream to be measured may be obviated by causing the water to flow over a weir placed in the channel. By this arrangement only the width and depth of the stream need be considered. But a measuring weir can be used only where there is considerable fall in the bed of the stream to be measured, most of the ditches in the Salt River valley having too little fall for this purpose. The Cippoletti weir is the one now generally used where conditions are favorable.

The following is the most practicable simple method of water measurement in this region: Place in a straight part of the stream a plain flume eight to sixteen feet long, and of a definite width. Then ascertain by a float or a current meter, what the velocity is when the water flows at each of various depths, in the flume. By checking the water some distance back of the flume, and letting pass through definite varying amounts, it can be thus caused to flow through the flume to the depth of one inch, one and one-half inches, two inches, and so on, successively. By ascertaining and recording the velocity of the stream as it flows through at various depths, the flow of the stream at these depths can be tabulated and kept for future reference. If the banks of the ditch above and below the measuring flume be kept in the same condition as when the guaging of the flume was done, the flow may be ascertained at any time by noting the depth of the water and referring to the table prepared. The measurement of the depth of the water should be made midway between the two ends of the flume, which should be placed and maintained in a horizontal position in both directions. For convenience, a thin ruled measure may be tacked to one side of the flume.

AMOUNT OF WATER USED UPON FARM.

A beginning was made during 1900 in keeping a record of the amount of water used upon the farm and of that applied during the development of individual crops. Unfortunately, the farm is not so situated that the measurement and division of the water that flows upon it is an easy task. The fall of the ditch leading to the farm and of the ditches upon the farm is too slight to make the use of Cippoletti weirs possible. Hence it has been necessary to measure the water in flumes placed at the same level as the bottom of the ditches. The triangular shape of the farm has increased the difficulties. However, it is believed that a fairly accurate record has been kept, and that a close approximate to the water actually applied has been obtained. As the work of recording the water has progressed during the two years, experience has made it possible to make more accurate measurements and keep more accurate records.

A record of the depth and the duration of each "run" of the water flowing through the ditch that supplies the twenty-eight acres of the station farm involved in this report, and a few small farms lying below it, is made by a water-register situated at one side of a gauged box placed in the ditch at the upper margin of the farm. A Y-shaped division box a short distance below the register separates the portion to which the station farm is entitled from that which is to flow on through the farms below. The station contracts with the water company for the delivery of 33 1-3 inches (the amount of its so-called water right) from the Grand Canal, and a varying number of inches from the Maricopa Canal. The farmers below contract for the delivery of forty to sixty inches of Grand Canal water and twenty to thirty inches of Maricopa water. Thus, when water was flowing from the Grand Canal, and forty inches had been contracted for by the farmers below, the station was entitled to thirty-three and one-third, seventy-three and one-third, or five-elevenths, of the total amount flowing in the ditch; and when water was flowing from the Maricopa Canal, the station was entitled to another definite fractional part of the total amount. These fractional portions of the amount that, according to the water-register, passed through the ditch are taken as the amounts used upon the twenty-eight acres of the station farm during the different "runs." It is to be understood that after contracting with the water company, which under our existing system has entire control of the distribution of the water to users, the station has no voice as to the amount of water that shall pass through the ditch leading to the farm, its only prerogative in the matter being to properly separate its portion from the remainder of the ditch content.

The amount of water used upon the twenty-eight acres of the station farm supplied with water from the ditch mentioned above, during each month of the period during which a record was kept, is as follows:

TABLE IV.—IRRIGATING WATER RECEIVED AT FARM.

1900.	Amount received from Grand canal. Acre feet.	Amount received from Maricopa canal. Acre feet.	Total amount Received. Acre feet.
June	3.15	6.10	9.25
July	2.80	6.25	10.05
August	11.85	6.75	18.60
September	6.10	8.15	14.25
October	5.40	2.90	8.30
November	3.20	6.10	9.30
December	4.35	4.05	8.40
Total	37.85	38.30	76.15
1901.			
January	12.50	5.10	17.60
February	13.20	9.80	23.00
March	13.10	8.90	22.00
April	10.20	10.00	20.20
May	8.05	5.55	13.60
June	3.85	4.45	8.30
July	6.45	2.50	8.95
August	7.65	9.95	17.60
September	3.00	3.40	6.40
October	4.50	3.60	8.10
November	3.55	2.60	6.15
December	3.20	3.30	6.50
Total	89.25 a. ft.	69.15 a. ft.	158.40 a.ft.

A comparison of the above amounts of water received from month to month at the farm with the rainfall record and the river flow during the period will show that there is a more or less close relationship between the three. In the main the flow of water in the ditch fluctuated with the flow of the river, as modified by the storms in its watershed. No rain falling during December, 1900, the amount of water available for irrigation was unusually small. The rains of January, 1901, increased the flow of the river and of the amount of water in the canals. During February, owing to heavy rains in the watershed of the river, the maximum amount that the canals and irrigating ditches would carry was distributed to the farmers. The amount received at and used upon the farm during that month was, according to the water register, 23.0 acre feet, sufficient to cover the entire twenty-eight acres with water .82 feet, or nearly ten inches deep. A large part of this was used upon the orchards, which were irrigated heavily during the winter. During the succeeding two months, owing to the melting of snow in the mountains and to light rains, the amount delivered at the farm continued high, the amount received during the first four months of the calendar year 1901 being over one-half of the total amount received during the year. During May, June and the most of July, 1901, the amount received gradually decreased. The rains of the latter part of July and of August increased the flow in the canals, the amount received during the latter month equally that of January. During the remainder of the year, with the exception of a brief period following the October rain, the flow remained low. The times of the year when the small amount received affected field operations most was during the latter part of May, during June, July, and again during September and October. The weather being warm and dry during these months, an increased rather than a diminished supply of irrigating was needed, emphasizing the importance of having stored for summer use the water that flowed down the river to the ocean during winter.

The total amount received at the station farm was only a small portion of that contracted for with the canal company. Experience having shown that only a small proportion of the amount contracted for is delivered, farmers have adopted the custom of contracting for and paying for the delivery of much more than they could possibly use, if the amount contracted for were actually delivered to them. The times of making these contracts with the canal company is September 15 and May 15. It being especially important that operations at the station farm be not interrupted by a shortage of irrigating water, the aim has been to contract for enough to as nearly meet the requirements as practicable. Hence, during September, 1900, the delivery of forty-three and one-third inches, or a little over one second foot, was paid for by the station in advance at $2.25 per inch, a total of $97.50 for the twenty-eight acres, or $3.48 per acre. The payment of $53.35 for so-called water-rights makes a total of $4.67 per acre per year for the irrigating water used. The total amount received from September, 1900, to August, 1901, inclusive, equalled an average of 14.25 acres feet per month, or a continuous flow of approximately 9.6 inches, instead of the forty-three and one-third inches contracted for. Even during February, 1901, the month of greatest flow, when all canals and ditches were carrying the maximum quantity that their capacity enabled them to carry, only an equivalent of fifteen and one-third inches continuous flow was received at the farm, indicating that it would not have been possible under any circumstances to have delivered to all consumers the water for the delivery of which each had contracted and paid, through the canals the company were operating.

The total amount used upon the station farm equalled an average of 6.0 acre feet per acre for the year. This amount is somewhat larger than would be necessary to produce the same yields during an average year, as the weather conditions of the period were somewhat trying. It is also to be understood that upon several fields, two crops were grown during the year, in one field melons and corn following potatoes, and in another corn following melons. Furthermore, to part of the orchard more water than was essential was applied during the winter when the supply was in excess of the immediate demands of the growing crops. The fluctuation of the water supply causes a much smaller crop return than would be obtained from the same annual amount delivered as needed during the year. Or, to state it another way, the same results as those obtained during the year might have been obtained with a considerably smaller water supply, had it been delivered as the crops needed it. Six of the twenty-eight acres lay idle from May to November because of the water supply being insufficient during these months to cultivate all the farm; and the yield of several crops would have been greater, had it been always possible to apply water at the most advantageous time.

(CONTINUED.)

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,
Expert in Drainage and Irrigation, U. S. Department of Agriculture.

From Farmers' Bulletin No. 187, Courtesy U. S. Department of Agriculture.

(CONTINUED.)

UNDERDRAINAGE.

The history of drainage shows that a great variety of methods and materials have been employed in the work, many of them effective and all of them aiding to demonstrate its usefulness in agriculture.

USE OF TILES.

The use of drain tiles for this purpose, introduced in England about the year 1810, has increased to such an extent and the art of using them has been so perfected that the tile-drain is now regarded as the best type of underdrain. Well-burned clay pipes of circular form, one or two feet long, are laid through the soil in a continuous line upon such a grade that any water which finds its way into them will be carried by gravity to some lower point, thus conveying the surplus away. The water enters the line of tiles through openings left between the ends, or "joints," as they are commonly called. The ends of the tiles should be placed close together in order to prevent the soil from entering, yet not so close as to prevent the entrance of water. The action of the tile-drain in removing the surplus water from the soil is as follows:

The drain being surrounded by soil the spaces of which are filled with water, the water in the soil flows by gravity through the crevices between the ends of the tiles, thus entering the drain, and passes off more or less rapidly, according to the grade upon which the line is laid. Other water of the soil takes the place of that removed, the water of saturation gradually passing from the surface downward, the soil near the level of the drain being the last to be relieved. The water moves downward and laterally toward the drain, and the lateral distance to which the drain will relieve the soil of water is governed by the resistance which the soil particles offer to the flow of water among them. This process does not leave the soil without moisture, but only removes the surplus. It does not, however, remove it from points below the level of the drain.

KINDS OF TILES.

The tiles used should be round in form, straight, and above all well burned. They need not be vitrified in order to be lasting, but whatever kind of clay is used in making them, every particle should be completely burned. Such a tile is then almost indestructible in earth and water. Where exposed to long-continued freezing and thawing, as at the outfalls, the best vitrified pipe should be used. After one has become familiar with the ware of a particular factory, properly burned tiles may be readily distinguished by their color and by their ring when struck with a piece of steel. Good clay may usually be semivitrified if skill is used in burning. Porosity of the finished ware is not important, since the quantity of water that will pass through the walls of well-burned tile is practically nothing. All water enters at the joints. Vitrification, although not essential, is always a desirable quality in drain tiles.

DEPTH AND DISTANCE APART OF DRAINS.

To secure efficient drainage the individual lines

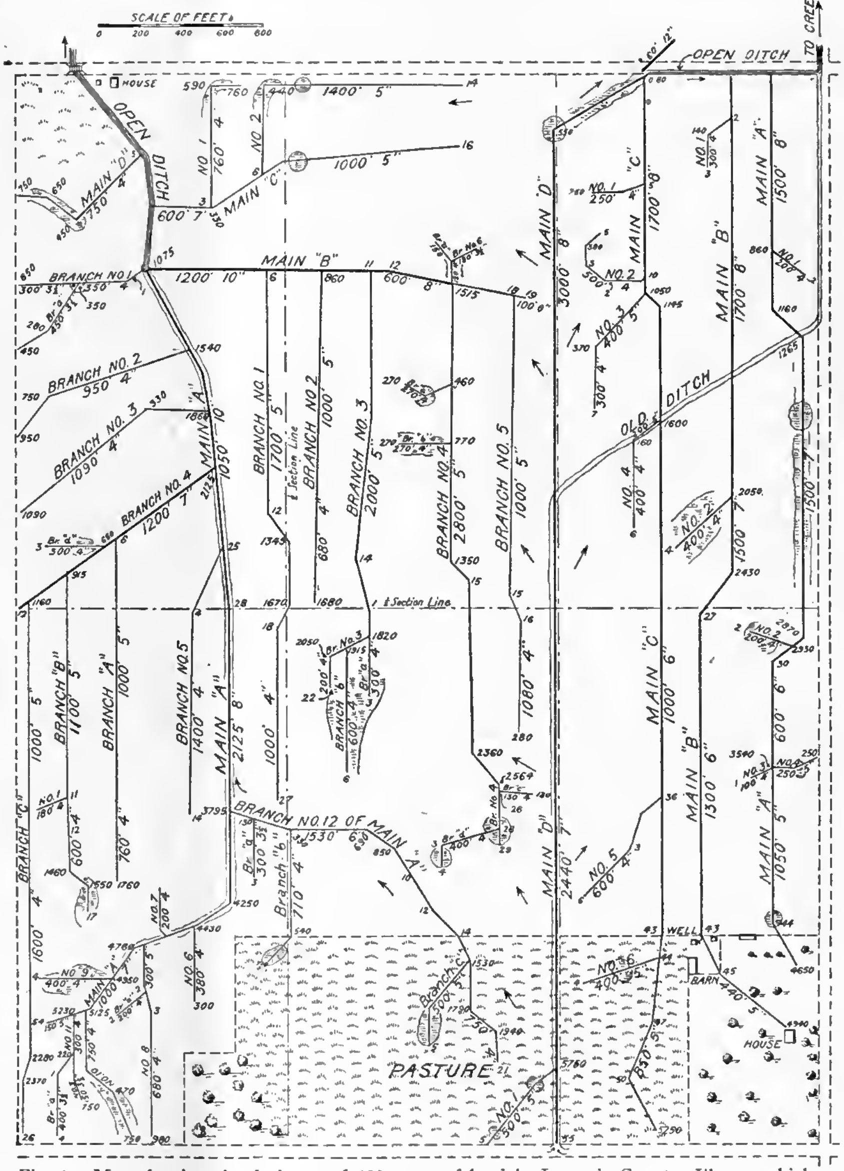

Fig. 9.—Map showing the drainage of 480 acres of land in Iroquois County, Ill., on which 69,700 feet of drain tile were laid three and four feet deep.

should be placed sufficiently near to each other for the effect of one line to reach that of another on either side so as to bring all the soil within the active range of the drains. The distance apart will depend upon the closeness of the soil, or, in other words, upon its retentive character. Soils are spoken of as "open" or "close"

with respect to their drainage properties, all variations in each class being recognized and requiring drainage treatment according to their several characteristics. It follows that in practice drains are placed from 30 to 300 feet apart and from $1\frac{1}{2}$ to $4\frac{1}{2}$ feet deep. These various conditions can not be described in sufficient detail to give a clear understanding of the requirements of each soil. In case of doubt regarding the proper distance apart for drains, they may be so placed that in case more perfect drainage is required a line may be laid midway between the lines. In general, close soils which consist largely of clay should have drains from 40 to 75 feet apart, and open soils from 80 to 300 feet apart. In the first instance, which is the more frequent system, tiles $2\frac{1}{2}$ to $3\frac{1}{2}$ inches in diameter may be used for laterals, and for the greater distance those $3\frac{1}{2}$ to 5 inches in diameter should be used. It may also be said that one line of 5-inch or 6-inch tile may sometimes be used in such a way as to afford good drainage to an entire field.

Depth of drains is also a variable distance, depending upon the same soil characteristics. In some cases drains have been laid four feet deep with indifferent results, while drains two and one-half feet deep on the same land have been attended with gratifying results. In general three feet is a proper depth for average soils, yet a depth of two or two and one-half feet produces better results in some soils. Drains should be placed as deep as they will receive the water readily, with four feet the limit in clay and alluvial soils. Aeration of the soil is one office of the underdrain, and of great benefit to very close soils. In treating such soils it has been found beneficial to provide surface vents to the drains for the purpose of inducing a more rapid circulation of air through the drains and soil. In this way some refractory soils have been drained and greatly improved in texture. Shallow drains in such cases serve the purpose better than deep ones.

LOCATION OF DRAINS.

To begin with, there must be an outlet suitable for the system of underdrains which it is proposed to construct. A field or farm may sometimes be thoroughly drained by simply laying tiles in those parts which are uniformly too wet for profitable cultivation. This is on the theory that the other parts have sufficient natural drainage. In such cases main lines should be located in the course of natural surface flow, with due regard also to straight courses. Branch lines should follow the same general law. This does not mean that the curves and crooks which are always found in natural depressions should be followed; straight courses joined by curves should mark the lines for drains.

Land which requires drainage always lies in natural areas of greater or less size, each having one point to which all the drainage must finally come. These general areas are again divided into subareas, each having its outlet within the limits of the general area. The boundaries of these areas should first be determined and the plans so made that when the drainage is completed the entire tract will have been provided for. A failure to do this is a fruitful source of disappointment in drainage work. The main drain should be located in the natural depression, with subdrains at such points as will furnish outlets for the tributary section. These are the arteries, as it were, of the whole system. This work may be carried out in two different ways. The first is to locate branch lines so as to reach those parts of the tract which are particularly in need of drainage, such as ponds, swales, sags, etc., without special regard to systematic work. This is called random field drainage. The second is to supplement the primary network by constructing laterals parallel to each other and at equal distances apart, according to the requirements of the particular soil, on the theory that every part of the field requires equal drainage.

Fig. 9 shows the plan used in draining a tract of 480 acres in Iroquois County, Ill., which is generally level, but was, before drainage, diversified to some extent by ponds which contained water during six months of the year. The grades upon which the drains were laid were in some cases one-half inch to 100 feet, varying from this to two inches to 100 feet. The object of drainage was to fit the land at a minimum of expense for the production of hay and grains of various kinds. It should be observed that the drains were staked out in a systematic manner. As shown on the plan (Fig. 9), each line is designated by some name by which it is distinguished from others. Its length, as well as its junction with other lines, is indicated by the number of feet or the station number from the outlet point in each case. This plan also illustrates various methods of location and arrangement of drains ordinarily required. The drains of this tract have been in successful operation for fourteen years and are admirably adapted to the purpose for which they were constructed. There have been no repairs or stoppages of any kind during that time. The land is an open black soil with joint clay subsoil which drains quite readily. The final outlets, as shown, are open ditches leading to the larger water course.

The most economical system for thorough drainage is that of parallel lines of a good length. This will be readily acknowledged when it is seen that, wherever one drain joins another, the soil in the vicinity of the junction has two drains acting upon it instead of one; in other words, it is doubly drained. In such soils laterals should be laid up and down the slope and not across it as advocated by many. It would doubtless seem incredible to those who find it necessary to place drains only forty feet apart that other soils may be drained as thoroughly with parallel lines 100 feet or even 200 feet apart. In the latter case, however, the laterals should be not less than four or five inches in diameter.

While, as a general rule, drains should be laid up and down the slope, there are special cases where the other plan is more effective and will accomplish the desired end at less cost. A case of this kind is illustrated in Fig. 10, which shows a pond surrounded by lands with steep slopes. The subsoil of the sloping land is open and porous, absorbing the rainfall readily and permitting water to flow through to the base of the slope, where, being checked, it accumulates and forms a border of wet ground around the outer edge of the pond. The line located through the center of the pond does not affect this wet strip, since the soil at the outer edge of the pond is less pervious to water than the soil of the hillside. By reason of this resistance and the continual head of water supplied by the hill, the base is kept saturated. An intercepting drain laid near the base, as shown in the illustration (Fig. 10), is the

Fig. 10.—Intercepting Drain.

most effective way of treating such cases. There are also long level sloughs having steep side slopes which furnish a constant supply of water by seepage at the base of the slope. Drains at the upper edge of the saturated strip will intercept the seepage water before it is forced to the surface by the pressure of the water above.

SURVEYS AND GRADES.

Whatever may be said to the contrary, it remains a fact that in order to get the best results in a system of drainage the work should be laid out with a leveling instrument and executed in accordance with the survey made. No one can be relied upon to guess a grade correctly, nor can any one arrange a system of grades with economy and at the same time get the best possible work out of the system without first knowing the facts as determined by the level in the hands of one who is able to use it. The drainage engineer can stake out the lines, adjust the grades, and put the work in such shape that it can be executed with precision, either by contract or day labor. The results of the work can be predicted with reasonable certainty before a ditch is opened. The drainage engineer, with the aid of the farmer who is familiar with the soil, can plan and lay out the work to far greater advantage than the inexperienced man. The farmer or superintendent can then give his attention to the execution of the work and insist on having it done according to the plans and surveys without the misgiving that it may be entirely wrong. Where there are large tracts of level land, or of land so nearly level that it can be drained successfully only by the most accurate work with instruments, the services of an engineer are indispensable. Where the land is somewhat rolling, the farmer may be able to adjust the grades himself.

The slight grades upon which lines of tiles may be laid with satisfactory results are a surprise to many; indeed, they were regarded as entirely impracticable until the experience of recent years proved the contrary. Lines of drain tiles laid on a grade as low as one-half inch per 100 feet in firm soils will operate successfully, provided the lines are not too long, while drains laid on grades of one to two inches per 100 feet may be counted by the hundreds of miles, and their successful operation is attested by thousands of acres of cultivated lands. It is not difficult to impress upon the mind of anyone who will give the matter attention the fact that such work must be laid out with accuracy and executed with thoroughness and skill. It should be observed in this connection that the fact of a drain having a good grade should not be made an excuse for careless and inaccurate work, though it is conceded that the consequences would be less serious than where the grade is necessarily light. Where a grade can be adjusted as may be desired, three inches per 100 feet or one-half inch to the rod is regarded as ample for tile drains. The increase of the size of the drain as the grade is diminished is a principle that should be kept in mind in laying out work, since grades must be largely controlled by the natural slope of the land.

It is not intended here to convey the idea that drains can not be laid by guess by observing the flow of water or by the hand level, nor that apparently good work has not been done in this way; but numberless mistakes, involving great waste of labor, and failures in the attainment of the best results from the work, empuhasize the wisdom of securing the best possible preliminary plans as well as their intelligent execution.

SIZE OF TILES TO BE USED.

The proper size of tiles to be used in the construction of drains is a matter upon which there is great difference of opinion, and accordingly of practice. It is doubtful if there is any part of the work requiring more careful consideration than this. Much difference of opinion on this subject arises from the fact that various soils respond differently to drainage work.

There are several questions to be considered in determining the size of tiles that should be used, especially for mains to a drainage system:

(1) What depth of water per acre will it be necessary to remove from the land in a given time, say twenty-four hours, in order to secure the desired condition of the soil?

(2) How rapidly will the water be brought to the main drains?

(3) What surface drainage does the tract have that will be available for carrying unusual rains?

(4) What is the nature of the soil as regards its drainage properties—that is, is it open or retentive?

(5) What are the grades upon which the drains must be laid?

As to the first question, it may be answered that there are times during the growing season when the entire ordinary rainfall will be taken up by the soil. At other times, when the rains are frequent and heavy and the soil becomes filled with water, it may be necessary to remove a large part of what falls in twenty-four hours. There are times when the rainfall is so heavy that the water can not pass through the soil fast enough, even if the drains are sufficiently large to carry it off, but a part must run off the surface, by its various depressions and channels, and these it is always wise to provide.

The total rainfall varies in the different States and sections quite materially. Drainage, however, has to deal with the extremes of rainfall rather than with the mean, when the size and efficiency of drains are considered, although it is generally true that the sections having the larger annual rainfall are subject to heavier storms. There are so many unforeseen conditions to be met with that to treat the problems in an analytical way in this connection will not contribute to any clearer understanding of the best practice now followed. Laboratory experiments made for determining the relation of rainfall to drainage are often so different from field conditions that they aid us but little in practical drainage problems. Deductions from the actual working of drains in lands of varied character and in different localities give us the most valuable data upon this point, and these have been the guides used in the following discussion.

If the main drains have a capacity to remove one-half inch in depth of water from the entire tract in twenty-four hours, they afford what may be regarded as good farm drainage, for, as ascertained by observation, even one-fourth or one-third inch in that time is the limit of capacity of many drainage systems in well-improved alluvial soils. The soil is a great reservoir and will hold from 25 to 40 per cent of its volume of water. In localities where no advantage can be taken of the surface flow for relief in times of heavy rainfall, mains may be used large enough to carry off one inch of water in twenty-four hours. Ordinarily for lateral drains no smaller than three-inch tile should be used.

(TO BE CONTINUED.)

THE PRIMER OF IRRIGATION.

Chapter XIII.

THE SCIENCE AND ART OF IRRIGATION.

The main object of irrigation should always be borne in mind; that is: nature having withheld from plants the moisture necessary to their growth, it becomes necessary to supply the omission. When that object has been attained, the work of the irrigator ends, and to continue farther would be detrimental to the soil, and injurious to plants instead of beneficial.

Given a certain tract of land, and a water supply, the question which confronts the irrigation farmer is: How shall the water be applied to the best advantage? It must occur to him that there can not be one fixed, rigid system of applying water to the soil, for he can perceive by looking about him that there are widely different varieties of plants, and opposite conditions of soil which preclude a uniform system of irrigation.

Scientific writers, and practical men, those who have studied the subject from the earliest ages, and in every country, have suggested more than a dozen different systems, but practical irrigators of modern times, men who have acquired experience by practical experiments, some of them costly, in our sixteen arid and sub-humid States, have settled upon four distinct systems of irrigation as amply sufficient for every condition of soil and climate, for economically supplying plants and soil with life-giving moisture.

Let the reader recall what has already been said on the subject in previous chapters, that except in the case of aquatic plants, it is not water or rather wetness that is essential to the perfection of plant life, but moisture. True, it is from water that moisture is derived, but when water is converted into moisture it is no longer water, but plant food. When a man eats meat and vegetables, he is not eating oxygen, hydrogen, nitrogen, carbonic acid, and the like, he is eating, however, combinations of those chemical substances, combinations which he, himself, can not create by devouring the chemicals themselves in an original state. To attempt to do so would be his speedy death, notwithstanding the theories concerning the value of dieting on certain artificial chemical combinations known as "health foods."

Water is poured into or upon the soil; gravity draws it downward; the particles of earth seize upon what they require, and the surplus water continues to descend until it reaches a water table, or is carried off through drainage appliances. Then capillary action begins, and the moisture ascends, and it and the nutritive elements it has gathered from the soil is seized upon by the roots of plants and devoured, that is absorbed, and the plant grows and waxes perfect upon the meat with which it is fed.

The four systems of irrigation referred to are as follows:

First—FLOWING, or ditch irrigation, where the water is run over the land through ditches or furrows intersecting the land to be watered.

Second—FLOODING, where the water is made to cover the land entirely at any desired depth, and is either allowed to remain stagnant, or stationary, or possesses a slight current.

Third—INFILTRATION, or seepage, in which the water is carried to the roots of plants by means of open ditches, or through subterranean waterways, in which case it is termed SUB-IRRIGATION.

Fourth—ASPERSION, or sprinkling, in which the water is applied in a shower, or as an imitation rain. Watering with a common garden sprinkling pot, or rubber hose, will give an idea of this system.

The first of these systems constitutes irrigation in the strict sense of the word, wherever water is utilized as a fertilizer of the soil, or an agent of humidity or moisture. The latter system relates to watering small garden plants, and flowers, and is commonly applied by means of some sprikling apparatus suitable to the size of the garden patch, and the quantity of water to be applied. It is not serviceable in hot dry regions and seasons because of rapid evaporation which makes it less economical than the others.

The choice of these systems, excluding the last, is subordinated to the nature of the soil, and topography, or "lay" of the land, the species of plants and the kind of culture, the quality and level of the water, and particularly to the disposable volume of the latter. In fact, two principles based upon the volume, or quantity of irrigating waters, regulate their use: The utilization of the maximum quantity of water obtainable to irrigate a given surface, or an increase of the irrigable surface to correspond with the maximum quantity of water.

The first principle is applicable to the sub-humid sections where there is a certain amount of rainfall in the winter months with dry summers, or a "dry season," like the Pacific Coast States, New Mexico, Arizona, and portions of Texas, or snow in winter as in Colorado, Wyoming, and the other northerly States.

In these localities, the rain and snow store in the soil a greater or less volume of water, which serves not only to fertilize it, but to keep it in a condition which will enable vegetation to either continue to grow without stopping, or to sprout in the early spring without preliminary irrigation.

In the warmer regions, however, there are dry belts, where the rainfall is so slight as to be unserviceable to perfect a crop, and in these belts little will grow without irrigation. To these localities may be applied the second principle.

Between these limits, principles, or conditions, are grouped numerous variations in plant growth, in aid of which irrigation supplies the means of rationally utilizing water for crop growing purposes. These variations will be taken up under the explanation of the four systems alluded to.

FLOWING, DITCH AND FURROW IRRIGATION.

On a naked tract of inclined, or sloping land, water follows the heaviest grade with an increasing speed or flow. When the same tract is covered with growing plants, the flow of water is retarded by the resistance of the plants, until an equilibrium is established, which requires more or less time according to the steepness of the grade and the character of the plants, and then the water flows with a uniform velocity, the same as if the land were naked. When that equilibrium has been reached, reason tells the irrigator to stop the water supply or the surface will be cut into gullies.

When the grade is very slight, the water, being unable to attain sufficient velocity, is lost in the soil before it can cover the entire tract.

In the former case, the zone of irrigation must be narrowed, and in the second, the lateral or distributing

ditches must be brought closer together. When the surface soil is undulating, or irregular, the water spreads out unevenly, in which case the distributing laterals must be brought still closer together, and arranged to correspond with the irregularities to avoid gullying.

Flowing is adapted to land the slope or grade of which is between four and two per cent per running yard. On steeper grades, irrigation is effected more economically by arranging a series of levels or plateaus.

On feeble grades, the quantity of water increases by accumulation and remains longer in a stagnant condition, but in general, by this system of irrigation the water is more fully aerated and its fertilizing power increased.

On large fields, water flowing over steep grades being more rapid, the ditches or water furrows should be more numerous, to enable the soil to gather from the water whatever fertilizing material it holds in suspension.

Where the grade is very slight, drainage may be necessary to carry off an excess of water. After cultivation is always necessary as soon as the soil is in a suitable condition, from twelve to twenty-four hours being sufficient time according to the climatic conditions of heat and cold.

In all cases of ditch and furrow irrigation, it must be remembered that the less the number of distributing ditches or furrows, the less the quantity of water turned into the soil.

IRRIGATION BY FLOODING.

(Submersion.)

In the system of irrigation by flowing, whatever method be adopted, running water over the land, or drawing it from ditches through furrows, the best conditions for utilizing water are realized, that is to say, so far as movement, aeration, double use, and facility of distribution are concerned. It is possible to avoid direct contact of the water with plants, thus retaining essential atmospheric influences, and also regulating the temperature of soil and vegetation. In this latter case, it is reasonable to suppose that even in the arid, hot regions, the application of cold water direct from a mountain stream, or surface well, would check vegetation, an effect which is always deleterious to all growing crops.

But there are circumstances when flooding or submersion of the soil is not only convenient but more beneficial, inasmuch as it supplies the soil with moisture to a greater depth, thus furnishing deep rooted plants with food material. Reference to alfalfa will make this clear.

Irrigation by flooding is simply submerging a given tract of land, by covering it with a sheet of water more or less deep, and allowing it to remain upon it a certain time, to "soak" into the soil before drawing it off to use on some other tract.

On flat or level ground, preparations for submersion are simple and easy. It suffices to smooth the surface by reducing knolls and filling cavities or hollows by means of a plow, cultivator, or road scraper, and then throwing up ridges of earth or dikes around the edge of the tract to retain the water.

It is an essentially economical method of irrigation, and is adapted to land and plants which do not require continuous or periodical applications of water. Its advantages are that it irrigates uniformly; utilizes all the water applied, it being absorbed except the small fraction lost by evaporation. Again, it tends to enrich the soil more than any other system by giving the various organic and inorganic solutions suspended in the water time to be deposited upon and carried into the soil. Lastly, it insures the destruction of insects and their larvae injurious to plants.

Opposed to its advantages are the following defects:

The plants are submerged either totally or partially, and the essential atmospheric influences suspended; the surface of the land is cut into dikes which interfere with adequate cultivation, and the consumption of water is much greater in a given time than when the water is flowed upon the land. Exceptions might be made to include alfalfa, sugar beets, and heavy root crops—gross feeders—the proper flooding of which could not be detrimental, but on the contrary beneficial. It is, moreover, essential in rice culture, and highly beneficial in vegetable gardens, fruit culture and in vineyards.

NATURAL SUBMERSION.

Irrigation by flooding, though produced by artificial means, is effected by the operations of nature in many regions of great fertility and abundant harvests. Countries of immense extent are fertilized by periodical, or rather annual submersions without which the soil would be absolutely barren.

Such countries are Egypt, which is fertilized by the regular flooding of the river Nile; the llamas, pampas, and steppes of South America, which are boundless natural pastures, maintained by the periodical overflow of numberless streams and rivers, and whose fertility and plant growth could not be perpetuated by artificial irrigation through ditches, because of the absence of grade to allow flowing. In the zone bounded by the dikes and river bed of the Rhone, between Avignon and the sea, in France, the lands are submerged through their whole extent during the winter months. Cereals, alfalfa, vines, fruit trees and vegetables grow to perfection without other fertilization and with very little cultivation. The damages from these annual inundations, though not slight, are regarded as of little consequence when compared with the benefits derived from them.

Other regions might be specified if it were necessary to advocate the benefits of land flooding. We might go back into the misty ages of antiquity and point to the wonderfully fertile regions around the Euphrates and Tigris, and depict the glories of ancient dynasties that reached the pinnacle of earthly greatness through the fertilizing of land by flooding, and show how those powerful dynasties crumbled into dust when the lands were no longer thus fertilized, but this is intended to be a practical work with barely enough sentiment to make it readable.

ARTIFICIAL FLOODING.

It is possible for man to imitate or copy nature, even to surpass nature, for he can control his water supply, whereas that of nature is uncontrollable to a great extent and destructive—a combination of utility and damage.

There are two methods of artificial flooding or submersion of land:

If the irrigation water provided for ditch or flowing is not all exhausted by that process, it is run upon land especially prepared for submersion, and allowed to remain upon it stagnant for a certain length of time,

longer in winter than in summer, until it is all absorbed. Or, when there is at hand a greater quantity of water than is needed for ditch purposes, it is allowed to flow over the tops of the dikes, in proportion as fresh water is added, and then the water becomes flowing water to be utilized upon a series of submergible fields.

In the first case, that of stagnant or still water charged with mud or other fertilizing material and food supplies, the matter is deposited upon the soil, which, in the case of sandy soil, or light loams, fertilizes and consolidates them into consistency.

In the second case, where the climate is frosty in winter, plant life in the soil is protected; mud and soluble materials are deposited in less quantities, and the atmosphere, or oxygen in the soil is not completely intercepted for the benefit of weeds and deleterious plants.

LAYING OUT THE LAND.

The best arrangement of a tract of land designed for submersion, is to divide it into sections, or basins, by means of dikes or ridges, which may be thrown up by the plow. Each section, fed by the ditch, retains its water, the same being allowed to run into it laterally until it stops, and becomes stationary or stagnant. In this way the humidity in the soil is equalized or rendered uniform.

On large level tracts, or where the subsoil is impervious, the sections or basins may be enlarged. In that case the flow into the basins should be hastened so that every portion of the basin be covered simultaneously, otherwise the humidity would not be uniform. The only limit to the size or extent of these basins is the supply of water and the facilities for flowing it upon the soil. Several openings may be made from the distributing ditch to hasten the process, and the length of time the water is to remain upon the soil is gauged by its permeability. The soil should not be saturated unless a system of drainage is provided. This can only be determined by testing the soil after the water has been run off or is all taken up. If sodden, there is too much, if after a few hours it will not pack in the hand, it is ample. If the quantity of the flow of water justify it, a number of basins may be submerged simultaneously by openings made through the ridges or dikes.

Submersion without dividing the land into basins causes a great loss of water. During the daytime it is possible to regulate the flow of water, and with a plow, furrows may be run in various directions, or a hoe is often sufficient to direct the water uniformly over the surface. But at night, it is not so easy to control the course of the flow, particularly on large tracts of land. Night irrigation of this kind is practised, but the crop appears luxuriant in spots, which shows lack of uniformity in the application of the water.

As to the size of these basins to be submerged, the lay of the land and the water supply must be the guides. There are irrigated lands with submerged basins from the extent of a small garden patch up to a hundred-acre tract in alfalfa.

In extensive tracts, particularly cereals, beets, etc., flowing and ditch irrigation would be speedier and more economical than submersion, and in many cases more advantageous, particularly in the case of shallow rooted plants. Thus flowing is preferable in the case of barley, but submersion would be beneficial in the case of peas, the former spreading out its roots near the surface, and the latter thrusting them down deep into the soil. So, potatoes will not stand submersion, but beets can scarcely be drowned out. In rice culture, as has been said, submersion is essential.

Should the land have a slope or grade impossible to level, care must be taken to provide a lower dike sufficiently high to overcome the height at the top where the water supply enters, for in such case, the water at the top of the grade would barely cover the soil, but flow over the top of the lower dike and thus become flowing water and not stagnant or stationary.

Professor Schwerz, in his treatise on practical agriculture, thus refers to the advantages and the disadvantages of submersion:

"By inundating the soil it is easy to shield a field from any unfavorable temperature (heat or cold).

"The preparations for inundation are generally inexpensive. The food elements held in solution by the water have ample time to be deposited upon the soil. Insects injurious to vegetation, and which are not destroyed by ordinary irrigation, are totally destroyed, and the same may be said of noxious weeds in arid soils.

"On the other hand, many serviceable plants are drowned by prolonged inundations; herbs are rendered less hardy to changes of temperature, and hay and forage plants generally are of inferior quality. Inundation is deleterious at the flowering period of plants, though they can be irrigated beneficially in other modes. Finally, to inundate a large field rapidly throughout its entire extent is to consume an enormous amount of irrigation water."

From these considerations, the scientist draws the conclusion that, "The choice between inundation and ordinary irrigation must lie in favor of that ordinary irrigation, although in turfy, tough soils, or one very porous, inundation is more advantageous."

NEVADA'S ENTERPRISING SPIRIT.

Nevada's exhibit at the World's Fair will be full of interest and variety. Executive Commissioner Yerington visited St. Louis recently and accepted the completed Nevada State building and arranged for the installation of Nevada's collected exhibits.

In the Mines and Metallurgy Palace Mr. Yerington will exhibit specimens of 118 varieties of ore. Each specimen will be catalogued and the World's Fair visitor may ascertain the full history of the specimen. from what mine it was taken, when, its value, etc. Features will be the Yerington nugget, a 271-pound lump of ruby silver that was taken from the mine at Tonopah, and specimens of natural soap from the soap mountain at Elko.

A comprehensive agricultural and horticultural exhibit will be made, fine specimens in all lines having been secured.

In the transportation exhibit will be some marvelously beautiful saddles and harness. One saddle with silver mountings valued at $1,000 will be shown.

Models of the Wadsworth irrigation canal will be shown. This canal has been built at a cost of $1,000,000, and 75,000 acres of land that was arid have been converted into fertile fields.

The state building at the World's Fair is across the avenue from the Pennsylvania building. It is of the bungalow type and its interior is particularly inviting.

BROUGHT BY THE POSTMAN.

FLORENCE, ARIZ., April 15, 1904.

EDITOR IRRIGATION AGE, CHICAGO, ILL.

Of all the fifty delegates to the Ogden Irrigation Congress from Arizona, I had the distinguished honor to be the only one who opposed the repeal of the Desert Land and other laws from which the irrigation fund is derived. By means of railroad passes, handled by George H. Maxwell, an effort was made to get the endorsement of the Congress for this unworthy proposition, which all the world now knows is solely in the interest of the transcontinental land-grant railroads, that their lands and lieu-land scrip may become more valuable.

The recent exposé of Maxwell by his own words in his testimony before the House irrigation committee has shown the wisdom of the Ogden Congress in discrediting the alleged gentleman. I promised him more than a year ago that I would make his name stink from one end of the country to the other; but he has saved me the trouble by performing the public duty himself. That he has failed to work his schemes before the National Legislature, as he did at Ogden, is a matter for general congratulation and much of the credit therefor is due your valuable magazine.

At this time it might not be out of place to reproduce a letter written by Maxwell. It refers to the only "graft" he has been successful in working and was addressed to members of the mythical National Irrigation Association, whoever they may be besides the land-grant railroads which pay him his princely salary. The letter is as follows:

CHICAGO, ILL., February 14, 1903.

"Dear Sir—The National Irrigation Association is working for results. We want to see the irrigation works built, and the increased population and trade actually created.

"When completed the Tonto, or Salt River, reservoir in Arizona, costing $2,700,000, with a capacity of 1,500,000 acre-feet, will rival the Nile dam as a great engineering work. It will more than double the productiveness, population and trade of the Salt River Valley.

"To make the influence of the National Irrigation Association effective, it must be concentrated on specific projects which will demonstrate the benefits of national irrigation to the entire country, and this Salt River reservoir is such a project.

"*The Homemaker* for January contains in both the illustrated section and the editorial section articles giving in detail an account of this great project and my own work in connection with it. Read it carefully.

The enemies of the national irrigation movement, our estwhile opponents, who wanted the States to control the great work of reclamation, though scotched, are still active and venomous. They are leaving no stone unturned to undo the great work we have accomplished.

"'By their fruits ye shall know them,' is the rule by which the friends of the national irrigation movement, who comprise the National Irrigation Association, must be measured. So far it is a record of things done. Yours faithfully,

"GEORGE H. MAXWELL."

It will be seen by the above letter, Maxwell considers himself the great "I am" of the Reclamation service and that he has deceived others into the same belief, "the more's the pity."

The facts are these: First, the Tonto or Salt River project in Arizona can not prove otherwise than a dismal failure. If, as Maxwell says, the reservoir is to have a capacity of 1,500,000 acre-feet, it would take seven years to fill it, without draining out a drop of water. In 1902 according to the measurements of the United States Geological Survey there were but 211,313 acre-feet of water discharged at the damsite. (See First Annual Report of Reclamation Service, page 93.) In 1903 the discharge was still less and the present year, so far, has been no better. It is but fair to state that we have been having a succession of dry years and I have no disposition to distort the truth.

Second—If there is no water to fill the reservoir, there can be no electricity generated for pumping purposes, either for suffering Pima Indians or suffering farmers.

Third—There are more than 300,000 acres of land held in private ownership in the Salt River Valley and for the past three years there has not been a sufficient supply, even if it were stored, to amply irrigate one-third of it. Hence the folly of claiming that any Government land can be brought under cultivation, as was intended by the law.

Fourth—As Tonto is purely a private land scheme, worked up by Maxwell, the people of Arizona generally take no particular interest in it. There are hundreds of them who desire to file on homesteads under a Government reservoir, and they see no justice in exhausting our pro rata in the irrigation fund on a private proposition. This sentiment is prevalent even in the Salt River Valley, where land is held in blocks of as much as 20,000 acres by private owners and corporations.

I am among those who believe that corruption has been used in bringing about the selection of this unworthy project. I have not hid my light under a bushel, but months ago laid the facts before the Secretary of the Interior in carefully prepared charges against certain engineers of the Geological Survey. If there has ever been an investigation of those charges, I have not heard of it, and at last I am forced to the conclusion that the Interior Department is as rotten as the Postoffice Department has proven to be. CHAS. D. REPPY.

CHEYENNE, WYO., April 4, 1904.

THE IRRIGATION AGE, CHICAGO, ILL.

Dear Sirs—There seems to be a sentiment prevailing now in the East that the land laws are not suitable to the conditions existing in the West. I have never heard it said that the land laws are not satisfactory because they do not offer the proper inducements to settlement or because they do not protect the people who have built homes in the arid region. The claim is that the Government is being robbed and defrauded. I do not believe any person of average intelligence can read the land laws which have been attacked and understand how land can be obtained fraudulently, providing the officers charged with carrying out their provisions are furnished with such assistance as to make this possible. In transactions between private parties an inspection of property disposed of is essential, but when the Government extends patents to lands, whereby, it is said, great fraud has been committed, it is the exceptional case in which an officer investigates the conditions and satisfies himself for the Government that the law has been complied with on the part of the entryman.

As far as Wyoming is concerned, the people should be protected rather than the Government, as fraud is not common here, regardless of the inefficient administration of the land laws as far as inspection is concerned. If any change is made in the existing laws it should tend to make the acquisition of lands less difficult and there should be some provision whereby small ranchmen could secure at least a temporary control of a sufficient grazing area to support their live stock. The lack of such a provision has led to fencing the public domain; otherwise the cattle business especially would have become a thing of the past years ago. The Government should recognize this condition as a necessity and make the statutes conform to it instead of compelling those who engage in the cattle business to violate the law.

I have too much faith in the representatives of the Western people in Washington to believe that any great changes will be made in the land laws unless it be in the interest of those who are seeking to develop the country. The cry of fraud against the Government is seldom heard outside of the lobby headed by Mr. Maxwell and his object in seeking repeal of the land laws is too well known to guarantee him much support in the West. Sincerely yours,

CLARENCE T. JOHNSTON,
State Engineer.

FALLON, NEV., March 10, 1904.

THE IRRIGATION AGE, 112 DEARBORN STREET, CHICAGO, ILL.:

Enclosed please find postoffice order for one dollar, renewal of my subscription to IRRIGATION AGE for one year.

The practical courses outlined by your paper regarding drainage in agriculture as well as horticulture are on the right line, perhaps a little in advance of some communities, but sooner or later such communities must toe this line or be distanced in the march of agricultural progress.

Truly yours, H. ROWLAND LEE, U. S. G. S.

CROWN POINT, IND., March 20, 1904.

THE IRRIGATION AGE, 112 DEARBORN STREET, CHICAGO, ILL.:

Dear Sir—Will you kindly advise me what States afford the best opportunity for a civil engineer to become identified with irrigation work. I presume this work is generally projected and carried out on a large scale by capitalists who, often being non-residents, make such engineering hard to secure except for those in touch with them.

However, if there is any locality whereby districts are organized by local interests and carried on something after the manner of the Illinois drainage schemes, I will be pleased to learn of such. In a general sense I will be pleased to learn to what extent the services of an engineer are required by statutes in these enterprises; also to what extent such services are in demand by local land owners in the development of individual tracts.

Thanking you for such information as you can give or reference you can make of this inquiry to parites who will give me pointers for getting onto such work, I am

Truly yours, F. L. KNIGHT.

BROWNSVILLE, TEX., March 19, 1904.

THE IRRIGATION AGE, 112 DEARBORN STREET, CHICAGO, ILL.:

Gentlemen—Enclosed we hand you postoffice money order for $1.00, for which kindly enter our name as a subscriber and send us your valuable publication, beginning with the February, 1904, number. We send you under separate cover copy of the *Brownsville Weekly Herald,* calling your attention to our ad. therein and other interesting matter regarding this section of the country. As we desire to mature plans for economically irrigating our lands, you will kindly put us in communication with manufacturers of windmills, pumping and irrigation plants. Yours very truly,

THE BROWNSVILLE LAND & TOWN CO.
A. D. CHILDRESS,
Vice-President and General Manager.

NEWCASTLE, COLO., April 24, 1904.

THE IRRIGATION AGE, CHICAGO, ILL.

Gentlemen—Will you please answer this question: Suppose a man digs a well for irrigation purposes, an individual plant, on another man's ranch by his permission, or suppose he, the one digging the well, buys a site and then digs the well and pumps the water from this well, turns it into his ditch that he uses from the creek, when there is plenty of water in said creek, and there are others below him that have prior water rights to him, and this well is above high water mark out of the creek bed or the bed channel in which it runs, can this be an interference with these prior water rights? This case is in Colorado. Yours very respectfully, W. A. CONNER.

ALEXANDRIA, IOWA, April 20, 1904.

EDITOR IRRIGATION AGE, CHICAGO, ILL.

Dear Sir—Will you give me names and addresses of reliable manufacturers of engines from 5 to 10-horsepower, using crude Beaumont oil? Yours truly,

L. A. SAFFORD.

ROSWELL, N. M., April 23, 1904.

EDITOR IRRIGATION AGE, CHICAGO, ILL.

Dear Sir—Please send me a few copies of the issue containing article on Greeley, Colo., as there are a few farmers who want to engage in raising beets and alfalfa. Please send them by return mail and oblige.

Yours truly, A. S. HARPHAM.

GREAT SHOSHONE IRRIGATION PROJECT.

Government Will Spend $2,225,000 on This Work—Cody Will Relinquish Water Rights.

Secretary Hitchcock has approved the recommendation of the director of the United States Geological Survey for the undertaking, under the national irrigation act, of the Shoshone project on the north side of the Shoshone River, near Cody, and set aside $2,225,000 of the irrigation fund for the work. This action of the secretary is subject to the Government obtaining the right to irrigate the large tract of land now segregated under the Carey act and the water rights now on file for the irrigation of that tract.

On January 26, 1903, Governor Chatterton, as president of the State Board of Land Commissioners, offered to the Government, through the director of the Geological Survey, the lands in question if the Government would accept them for the purpose of reclamation, and at the same time he suggested that no relinquishment be made until the Government had fully determined to take up the enterprise; and while Messrs. Cody and Salisbury had taken out a water right for the irrigation of the lands in question, and Colonel Cody has been recently attempting to raise the funds for the irrigation of the tract, it is understood that he will not stand in the way of the Government.

As soon as the relinquishment of the State's rights to the segregated lands can be obtained and the question of water right adjusted the Government will proceed to the building of the project. The first section of this great enterprise will irrigate about 90,000 acres of land between Cody and Garland. When this is successfully accomplished some 20,000 or 30,000 additional acres on the drainage of Sage Creek between Frannie and Byron will be irrigated, and if sufficient water supply is obtained additional lands will be irrigated northeast of Cody on the drainage of Clark's Fork, extending to the Montana line and possibly beyond.

The main canal will have a sufficient drop northeast of Hart Mountain, in the vicinity of the old stage station between Eagles' Nest and Clark, to furnish power to elevate water for the irrigation of the splendid plateaus lying to the north of Garland flats. By the complete utilization of available water supply it is believed that this project will ultimately irrigate between 100,000 and 200,000 acres and constitute one of the largest and most successful irrigation enterprises in the world.

COLONIZATION FOR THE WEST.

Lute Wilcox, of the Denver *Field and Farm,* calls on the proposed Government bureau to help settlers locate on Western lands "a skin-grafting game." Senator Hanna would have introduced the bill had he lived, but Senator Fairbanks will now take charge of the measure. The proposition is this: The formation of a colonization bureau under the direction of a commissioner of colonization in connection with the Department of the Interior; the collection of reliable information for would-be settlers; the advancing to *bona fide* settlers of from $500 to $1,500 in cash or materials for the purpose of enabling worthy but poor families to make homes for themselves upon the lands; the issue of 3 per cent sixty-year gold bonds to the amount of $50,000,000, with not more than $5,000,000 to be issued each year, for such purposes, and the establishment of worthy families on farms which are not to exceed forty acres of irrigated or eighty acres of non-irrigated land to be paid for in easy installments. The bill is fathered by the Salvation Army and is one of the altruistic schemes of that nomadic organization. The probability of its passage hinges very materially on the Army's political pull at Washington. Mr. Wilcox says the people of the West are not especially interested in it.

CALIFORNIA OF THE NORTHWEST.

Great Work Done on the Columbia River in Kennewick County, Washington.

BY H. A. NOYER.

In the eastern part of Yakima County, Wash., at the junction of the Northern Pacific railroad and the Columbia River, is located what has been aptly termed the California of the Northwest. Here we find what is known as the Kennewick country. This valley, which has an elevation of only 350 feet above the sea level, was until a short time ago considered by many to be of little importance and of practically no value. However, since King Irrigation has been given sway wonderful changes have been wrought, and it has been proven that the soil, which is of an ashy volcanic origin, is the most productive in the State of Washington, and has few equals in the United States. The summer season here is from two to four weeks earlier in spring and later in fall than that of any other locality in the Northwest. This is due largely to the low elevation and the prevailing sunny skies.

The surrounding mountains form a natural protection and consequently this valley does not suffer from the extremes of either heat or cold which are so common in other parts. For example, the coldest weather that was had in this valley in 1902 was eighteen degrees above zero, and only about one-half inch of snow on two occasions. As a rule every day is bright and sunny. The dry, balmy air and perfect atmospheric conditions make this the most healthful location in the entire Northwest. This, in connection with the fact that this is a country where storms, cyclones, earthquakes, and such disturbances are unknown makes the California of the Northwest an ideal place for the location of homes, and there are already many beautiful homes in this valley and many people are engaged in adding to those already here.

Although the irrigation canal was completed and water turned on here only last April, yet during that time it has been demonstrated beyond a doubt that this valley will produce as fine fruit, berries, alfalfa and garden produce as can be grown anywhere. Alfalfa yields near ten tons per acre and often produces four crops during the season: this sells at from $6.00 to $15.00 per ton in the stack.

Garden tracts, after being set to fruit trees and berries, will return about $300 per acre per annum; thus the land will pay for itself in a short time. A peculiar advantage of this section is that destructive droughts, floods and storms are unknown. Its markets are furnished by the large lumbering, mining, manufacturing and wheat raising population of the Northwest, besides being tributary to a city population aggregating 450,000 in number. These conditions give the Kennewick coun-

High School, Payette, Idaho. Illustration furnished by C. E. Brainard, Manager of the New Plymouth Land and Colonization Co., Ltd., of Payette, Idaho.

try the best of advantages in marketing the products of the valley, and from the fact that these products are ready for the market from two to four weeks earlier than those of any other point in the Northwest, gives the farmers the benefit of the best prices with no competition. Of the entire West California alone can get produce on the market as early as this valley and from the fact that the fruits and produce raised here are of a better quality and flavor and do not have to be shipped so long a distance makes the California fruits a second-class commodity when compared with those of the Kennewick Valley.

The transportation facilities are of the best, as Kennewick is located on the Northern Pacific railroad's main line. Steamboat lines from Portland and other points will be established during the coming year, thus making it a natural trading and shipping point. Being thus favored by its geographical location, altitude, and natural transportation facilities, many wise and far-seeing men of other cities give it as their opinion that in a few years there will be here the largest city in eastern Washington.

42 PRINTERS' INK

EDWIN F. ABELL, head of the company that publishes the Baltimore *Sun*, died in that city February 28, aged sixty-three years. His father, A. S. Abell, was the founder of the *Sun*, which dates from 1837, and the deceased was the last surviving son, having had the management of the paper for ten years past. His death was, in a measure, brought on by grief and shock following the Baltimore fire.

THE *Irrigation Age*, published monthly in Chicago by the D. H. Anderson Publishing Co., has absorbed *Modern Irrigatian*, Denver. There are five publications in the United States devoted to the subject of irrigation, and the *Irrigation Age* leads them in point of circulation, being credited with a monthly average of 22,100 copies for 1903 in the Roll of Honor. The consolidation gives a further increase. The Denver publication made no statement of circulation, and was credited with H—exceeding 2,250 copies. The *Irrigation Age* is nineteen years old, and is said to have readers in all parts of the world among individual irrigators and irrigation corporations.

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We are reproducing herewith notice which appeared in the columns of PRINTER'S INK, the leading authority in the advertising field, for which we wish to thank the publishers of that journal and at the same time call attention to the fact that the combined circulation of the two journals is considerably more than the figure named.

CHEAP METHODS.

The following from a leading Denver publication illustrates the cheap methods adopted by a Denver publisher who wishes to profit by taking over the volume number of a journal purchased by and merged with THE IRRIGATION AGE. The attention of our readers is called to notice in another column from *Printers' Ink* concerning the merger.

"D. H. Anderson, the editor and publisher of THE IRRIGATION AGE, Chicago, the oldest journal of its class in existence, announces in its February number the purchase of *Modern Irrigation,* successor to *Irrigation Era,* of Denver, Colo. The absorption of *Modern Irrigation* by Anderson gives his already most excellent journal a much broader field and greater usefulness. Mr. Anderson is recognized as one of the leading authorities on irrigation subjects and is one of the strongest writers of the age.

A little chicken paper in Denver has improved the opportunity of this change to start a paper called *Irrigation,* and to fraudulently give it the volume and number of *Modern Irrigation.* This little paper hopes, in this way, to deceive the people and to create the impression that his paper is the direct successor of *Modern Irrigation* and is fifteen years old instead of one month. While the manager of this new paper has already succeeded in deceiving a number of advertisers, it is hardly probable that he will succeed in deceiving the postoffice authorities and that he will eventually be forced to adopt honorable methods and start his paper with volume one.—*Ranch and Range, Denver, Colo.*"

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—UNTIL YOU HAVE INVESTIGATED— **"THE MASTER WORKMAN"** A two-cylinder gasoline engine superior to all one-cylinder engines. Costs less to buy and less to run. Quicker and easier started; has a wider sphere of usefulness. Has no vibration, can be mounted on any light wagon as a portable. Weighs less than half of one-cylinder engines. Give size of engine required. Especially adapted for irrigation in connection with our centrifugal force pumps. (Sizes 2, 2½ 4, 5, 6, 8, 10, 12 and 16 Horse Power.) High-grade Gasoline Engines, 3 to 6 horse power—adapted for Electric Lighting, Marine and Pumping purposes. ☞ Please mention this paper. Send for catalogue. **THE TEMPLE PUMP CO., Manfrs., Meagher and 15th Sts., CHICAGO, ILL.** Established in Chicago, 1852.

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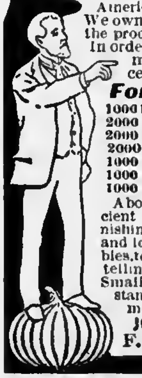

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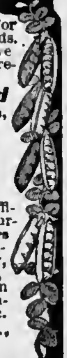

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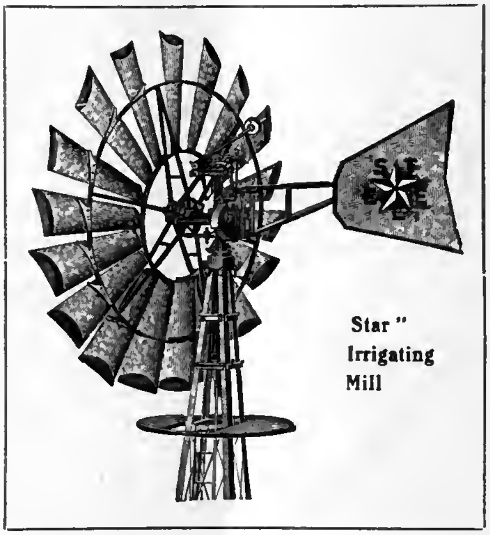
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VOL. XIX. No. 8.

THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

JUNE, 1904.

THE D.H. ANDERSON PUBLISHING CO.,
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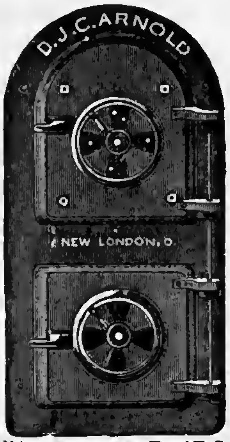

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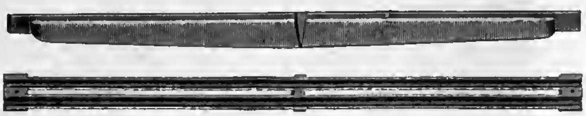

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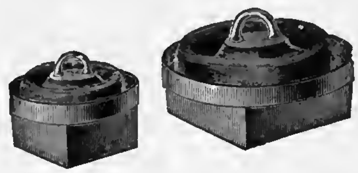

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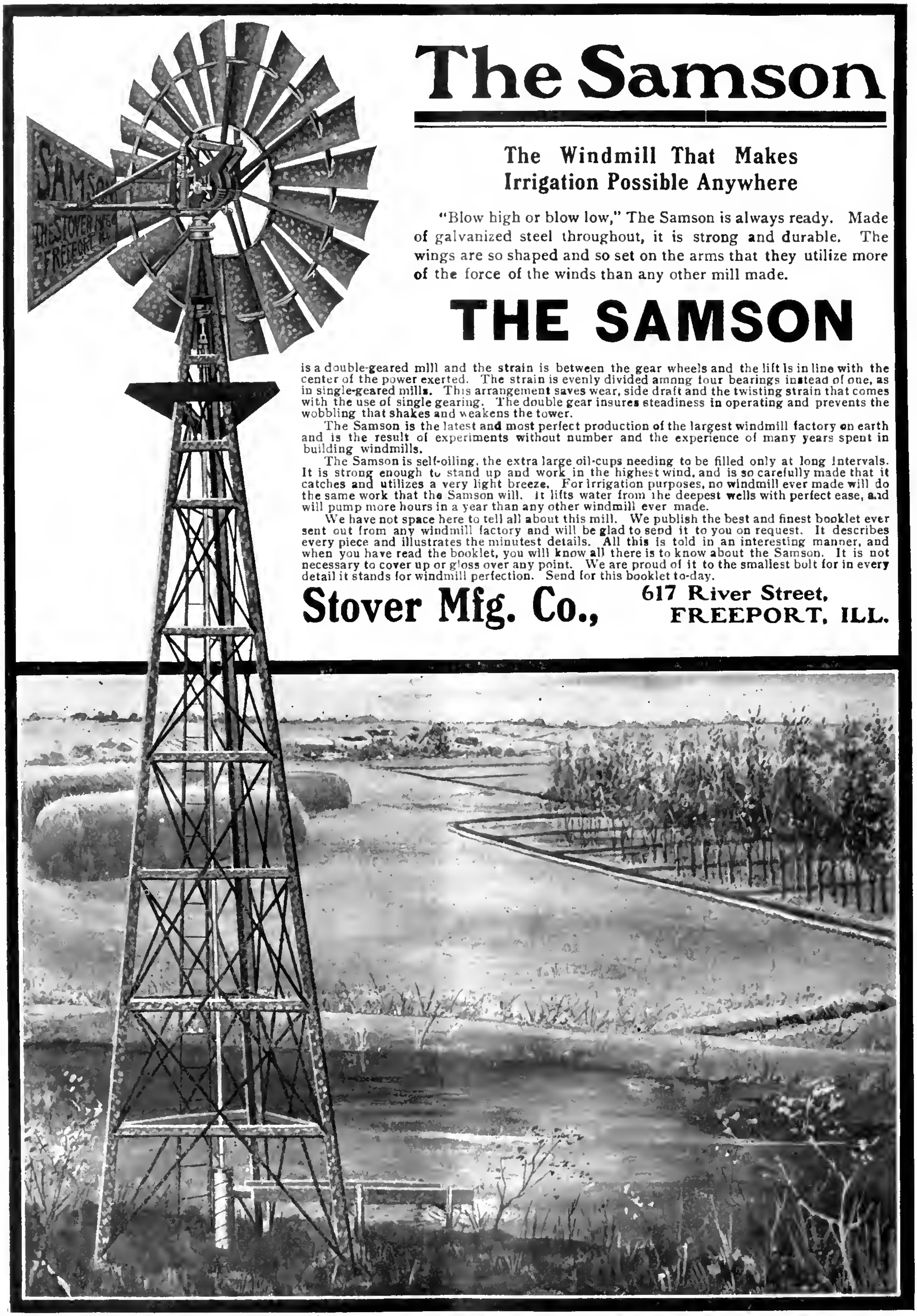
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THE IRRIGATION AGE

VOL. XIX | CHICAGO, JUNE, 1904. | NO. 8

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THE D. H. ANDERSON PUBLISHING CO.,
PUBLISHERS,
112 Dearborn Street. - - CHICAGO
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W. J. ANDERSON } Editors
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GEO. W. WAGNER, Mgr. W. L. JACKSON, Editor, Western Dept.

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

THE IRRIGATION AGE has been informed that an investigation has been started by several gentlemen, who are prominently placarded as officials of the National Irrigation Association, which will, no doubt, result in the resignation from that organization of a large number of manufacturers whose names have been prominently used by Maxwell and his crowd. If the proper steps are taken and the investigation is thorough there is no question but that all the men interested will resign and leave the association with only such members as are at present deriving a revenue therefrom. THE AGE will publish in the near future further information concerning the investigation which is soon to take place.

Our July Issue. In our July issue will appear a well-written and finely-illustrated article on "Irrigation Investigations of the Utah Experiment Station," by Dr. John A. Widtsoe, director. This article will treat of "The Antiquity of Irrigation," "Condition of Farming a Century Ago," "Development of Modern Farming," "The Neglect of Irrigation," "The Problems of Irrigation" and "Soil Problems of Irrigation." This will be a very interesting article and well worthy the attention of all our readers. Professor Widtsoe is a well-known authority on the subject and has made remarkable development along irrigation lines in connection with his work in Utah.

The American Irrigators' League. Our readers are requested to consider the suggestion of joining the American Irrigators' League. We would respectfully ask each subscriber to send us lists of farmers in his vicinity who would be likely to join for self-protection. Great benefits will be derived from membership in this league. It costs nothing to join and there are no expenses attached to membership. We wish a league division in each county of each State in the arid and semi-arid West. New names are being added to our list every day, and all are urgently requested to forward names to THE IRRIGATION AGE of those whom they think would be likely to join, or who would be benefited by association with the organization. The American Irrigators' League will take up and attempt to right the wrongs practiced upon individuals by large landowners and corporations. It will try to bring about harmony between individuals and aid in the settlement of controversies arising from the question of water rights, etc.

Warning. We have been informed by acquaintances of the Maxwell-Boothe organization that its managers make the statement that they will absolutely control the Irrigation Congress to be held at El Paso, Tex., in November. It is understood that Maxwell has arranged to secure transportation for a large number of Eastern delegates, whose votes will be used to swing matters to suit the above-

named combination. The true friends of irrigation development in the West will take warning and prepare to combat any effort which may be made by this crowd to run things their own way at El Paso. In this connection it appears that the railway companies are permitting themselves to be misrepresented when they allow such men as Maxwell to state publicly that by the use of free transportation furnished by the railways through him they will bring delegates so as to pass such resolutions at a national congress as will suit certain individuals. It is high time that the railway companies placed a muzzle on this man Maxwell, so he may not put them in a bad light before the public. His efforts at carrying out certain plans and developing special policies along irrigation lines have fallen so flat in the past that it is a wonder the railway companies or others still retain faith in him.

It is understood that several of the large corporations have become so thoroughly disgusted with his work that they have or soon will withdraw their support from the movement. It may as well be understood that the members of the American Irrigators' League will have something to say at the time of the El Paso congress, and if any effort is made to hoodwink the delegates, as in the past congresses, an exposure will take place that will put those back of these schemes in an undesirable light before the public.

Look Out —El Paso. Mr. C. B. Boothe, a henchman of George H. Maxwell, is carrying on the arrangements for the Irrigation Congress at El Paso with a high hand. He was elected or appointed chairman of the executive committee, and as such is playing into Mr. Maxwell's hands in a way that threatens to make a successful meeting an impossibility. We were informed a few months ago that the President had become acquainted with Mr. Maxwell's true character and had warned Mr. Pinchot and Mr. Newell to discontinue their co-operation with that gentleman. These officers of the Government have made an outward appearance of having done so, but no one who watches the progress of affairs can be deceived. The association is as close as it has ever been, regardless of the apparent attitude of unfriendliness which Mr. Pinchot and Mr. Newell manifest in public. Mr. C. B. Boothe secured the chairmanship of the executive committee of the Irrigation Congress last year through the cunning of Mr. Maxwell. Boothe and Maxwell have been feeding at the same trough for a number of years and, as was predicted early in the year, Mr. Maxwell has entire control of the arrangements for the Congress. Boothe has recently formed the following "sections" for the conduct of the program:

SECTIONS.

Forestry—Gifford Pinchot, chairman, Atlantic building, Washington, D. C.

Land and Water Laws—George H. Maxwell, chairman, Fisher building, Chicago.

Engineering and Mechanics—Frederick H. Newell, chairman, Reclamation Service, Washington, D. C.

Production by Irrigation.............Chairman.

Climatology—Willis L. Moore, chairman, Department Agriculture, Washington, D. C.

Does this look as though Mr. Maxwell and his friends in Government service were working in any manner but harmoniously? Mr. Moore was doubtless selected as a blind. To place a professional railroad lobbyist in charge of the section dealing with land and irrigation law and a mining engineer and geologist, who has never had experience in the Government work he now assumes to conduct, in charge of the section dealing with engineering and mechanics, is the acme of the ridiculous. The question now is whether or not the local management will stand for any such arrangement as Mr. Boothe has made The people of El Paso and Texas are interested in the success of the Congress. Will they permit it to be used as an instrument to further the cause Mr. Maxwell and Mr. Boothe advocate in behalf of the land and repealers and holders of land scrip?

The Irrigation Problem. The irrigation law of 1902 creates an empire within an empire. On the one hand are many sovereign States with supreme dominion over matters and things, persons and property within their boundary lines, powerless to enforce any mandate or law beyond those boundary lines.

On the other hand is the Federal Government, exercising uniform, universal dominion over its property, scattered through all the vast territory included within the sovereign State lines. There is not and there can not be any conflict of jurisdiction or dominion upon this point, both being sovereign within their spheres of jurisdiction, and each may enact whatever laws it shall deem proper and adequate for those subject to its dominion, without interference one with the other when acting within constitutional limits.

The national irrigation law expressly limits its operation to its domain scattered over many States and Territories specifically selected out of the total number of the United States, and omits all the remaining States. The law, therefore, operates only in a certain specified portion of the country and is inoperative in all the remaining portion.

Whence it may be said that it is practically special or local legislation, expressly and intentionally intended to benefit one portion of the country directly and to exclude from its benefits all other portions except indirectly as their trade and commerce may be benefited by the proper enforcement of the law upon lands reclaimed.

Considered, therefore, as special legislation, and from the letter of the law itself, it is impossible to consider it in any other light; the national irrigation

law must be carried out or enforced in a special and not in a general manner. That is, the laws of the State of New York and the other States of the Union omitted from the category of the national irrigation law, and the laws regarding the dominion of the Federal Government in those omitted States, have no operation or vitality in Wyoming and the other States specifically enumerated in that national irrigation law.

So far as the Territories are concerned, the Federal Government has full, unmolested sway in the carrying out of the national irrigation law, and whatever system it adopts that system must become a part of the organic law of the State erected out of the Territory. The reason is because those who accept that system and come in under its operation have acquired contract rights which must be respected. They can not be deprived of them without their consent.

But when we come to the States in which the double empire, so to speak, exists, the matter assumes a different complexion for the following reasons:

First—In the enforcement of the national irrigation law the Federal Government must either adopt a uniform system of irrigation or one that is diverse and in conformity with the laws of the States in which its objects are carried out.

Second—The irrigation or water laws of the different States over which the national irrigation law extends are not uniform, the ownership or right to the water for irrigation being diverse, even the measurement of the water being governed by different rules.

Third—The individual who takes up "Government land" with the water privileges accorded by the national irrigation law is bound to conform to the government of the federal authorities *until he has acquired an absolute title to the land, and then he becomes subject to the State sovereignty, the federal authorities having no further dominion over him or his land or to control the water.*

The rule of decision in the United States courts is that all federal laws shall be of uniform, general application or operation, however special they may be in their intent. Now, if the federal authorities adopt a uniform system of irrigation throughout the entire irrigation area, that system will conflict with the diverse State laws, and when the land which is now under the dominion of the Federal Government shall fall within the exclusive jurisdiction of the sovereign States, if the law of contracts can not be so twisted as to uphold him, there will be presented the curious problem of the citizen of the State violating the laws of that State, an individual setting its sovereignty at naught. This is an unthinkable condition, and the law of contracts will be apt to go by the board on the ground of public policy, and the man who relied upon the federal power to maintain his rights will find that power a broken reed from the very nature of our system of government.

The same result must ensue if the federal authorities adapt their system of irrigation to the diverse laws of the States in which national irrigation now operates. Some uniform system of irrigation must be adopted, and in that case, or in the case of any change in the law, the holder of former Government land will be compelled to change his system to conform to the changes in the State laws. The predicament is the same in both cases.

Under the second reason above given, it suffices to say that the diversity of the irrigation laws in the various States is self-evident. In some instances there is so great a lack of uniformity that, suppose a ditch to cross from one State to another, the right to use the water in the ditch in one State may be taken away, or so materially modified in the other as to be valueless. This is more important than appears on the surface, for it concerns streams traversing two or more States or originating in one State and flowing into another. Subterranean and all underground waters are implicated in this question. Who knows where the infiltrations of great streams or the seepage water ends or flows? Shall the State in which the water has its source own all its percolations, even into another State? A miner owns his ore ledge from the surface, or its outcrop, along all its dips, spurs and angles, regardless of the territory through which it passes, but to apply this principle to water is to immediately destroy the efficacy of irrigation, and to set back the reclamation of the arid and semi-arid empire to its desert condition, with only a few oases here and there belonging to the fortunate owners of the source of the water.

They stand substantially in the same position as interstate commerce, with this vital difference, that the individual water user is not a quasi-public corporation subject to regulation by the Federal Government, that power having lost its right to interfere the moment it confers absolute ownership in the land and water upon the individual, the private citizen who becomes, he and his land, subject to the purview of the laws of the sovereign State.

This last point covers what may be said under the third reason given above. If the individual meets with a conflict his only recourse is to court, but the federal courts will rule according to the rights of the Federal Government unless broadly contrary to its constitution, and the State courts are bound by their State constitution as their rule of decision. Hence, the irrigator as the party between the upper and nether millstone, is ground into powder.

What is the remedy to avoid the irritating questions liable to arise, to obviate a train of evils sure to grow out of the attempt to reconcile the differences which exist, and which must be eliminated or cured in the interests of the public welfare?

It is beyond the utmost power of any one man, or body of men organized or associated for private pur-

poses, or for public purposes looking to private gain, to apply any remedy which will establish uniformity in the matter of irrigation, because the work to be done is governmental in its nature.

We are building for the future by taking care of the present. We are on the threshhold of a domain sufficient to maintain from twenty-five to fifty millions of people, and which will be filled with that number of people within two generations. It was not two generations ago when it was difficult to find the city of Chicago, and it was much less than that period of time when a microscope was required to discern the city of Omaha. What is it now, this vast empire, and whence sprang the thousands of towns and cities that were once desert sites without human habitations? All has been created by private enterprise, and now, that the Government comes to the aid of this great empire, is not the building to go on much more rapidly? Shall it be hampered or restrained by private interests?

This question of irrigation must be regarded from a more enlarged point of view than that of the reclamation of arid and semi-arid lands. The humid regions, the States where the rainfall is sufficient to make the soil laugh with a harvest, are studying the problem of irrigation to obviate periods of drouth and to realize unfailing harvests. Large canning interests in the State of Illinois are contemplating the establishment of a system of irrigation and drainage to assure themselves of plentiful, luxuriant harvests.

We make the problem broad enough to prepare the way for the remedy which will obviate all the evils liable to arise from diverse systems of irrigation, and which, in time, if not provided against now will retard the entire nation, not only the arid and semi-arid States, but every State in the Union, for irrigation is agitating all of them.

From this viewpoint, the subject of irrigation becomes one of national importance and significance, not that the Federal Government is concerned in it, but because of questions that may arise between the various States when the water is interstate, as has been already mentioned. As soon as the General Government shall have disposed of its interests in its public lands to private individuals, it will have lost all interest in the problem of irrigation, it will have ceased to be a factor in their solution, and its active participancy in the settlement of questions even arising out of interstate questions will be an unwarranted intrusion upon the rights of the sovereign States, unless the latter, or its citizens appeal to the Federal courts, which is not a very satisfactory way of governing an empire.

Under our system of government, a representative body of the people is of the most signal influence in providing for the wants of the people. It is the essence of our free government, although we seem to be getting away from it and intrusting our rights to private individuals. In this matter of irrigation, which concerns the home, the vital rights of ownership over land and water, the relations between men and the State and between the latter and the General Government, all of the details of the question split into tens and soon to be split into hundreds of thousands of small side issues, the Federal Government can not be an active party, and the States can not operate beyond their own borders. Conflicting laws and burning questions involving the application of twenty inches or half an inch of water upon a given tract of land can not be settled in a manner commensurate with the needs of the parties involved, for our present methods of settling rights between individuals and States is slow beyond parallel; the individual is ruined before settlement is made, and the question becomes one of mere principle, which is of no application or merit when the cause demanding it has ceased to exist.

But if a representative body of the people, such as the American Irrigators' League, of the great body of irrigation farmers carry out the intent of their constituents; if that representative body is legalized and empowered to bring about uniformity in systems of irrigation, and unite with a commission duly authorized by the federal laws, there will be no more clashing of interests, but unanimity must ensue. A uniform system of irrigation must be adopted, one under which the man in California will receive water in the same legal manner as the man in Colorado; under which the man with a small home and his few acres will possess the same inalienable right to a sufficient quantity of water to maintain him in his independence as the man with a thousand acres.

There are innumerable watercourses to be diverted, chains of reservoirs to be created to impound the surplus, thousands of wells sunk to tap the inexhaustible water supply lying inert and unused below the surface of the most sterile desert. The use of water must be free and regulated only by a governmental body of men, who will see to it that private individuals do not pervert this freedom and convert it into a badge of servitude.

The national irrigation law as it stands is satisfactory, and the question of irrigation can be easily determined under its provisions until the time shall come when the Federal Government shall have no more land at its disposal; against the coming of that time there is no provision, and there can be no provision until that time shall have arrived. What can and what should be done is to prepare for it by unifying our diverse systems, harmonizing them so that they will fit into their proper place without confusion or irritating discussion. To alter or amend the acts of Congress now, to change the entire aspect of our land laws, is to insert the wedge of unlimited confusion and never-ending conflict instead of gradually smoothing the way for a settlement of the land and water problems.

REPORT OF THE INVESTIGATIONS IN IRRIGATION CARRIED ON COOPERATIVELY BETWEEN THE OFFICE OF EXPERIMENT STATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE AND THE STATE BOARD OF EXAMINERS OF THE STATE OF CALIFORNIA.

S. FORTIER.
In Charge Pacific District Irrigation Investigations, United States Department of Agriculture.

It is no easy task to supply food and clothing for 80,000,000 people. The American farmers during the past year have not only raised sufficient products to supply the home demand, but the surplus, when sold to foreigners, has reached the enormous sum of $878,000,000. Were it not for the cotton of Georgia, the tobacco of Kentucky, the corn of Illinois, the dairy cows of Wisconsin, the wheat fields of the Dakotas, the sheep of Montana and the fruits of California, this country could not afford to build the Panama Canal. Men are beginning to realize, as they never did before, that the wealth of this nation is derived from the soil and that national prosperity follows as the direct result of abundant harvests sold at fair prices. So long, therefore, as the soil can be made to yield profitable returns the danger of hard times will be averted. Prosperous farmers make a prosperous country.

S. FORTIER.
In charge Pacific Irrigation Investigations.

At the present time much is being done by both the National Government and the several States in aid of the farmer, the fruit raiser and the stockman. For a number of years the National Government has appropriated, in accordance with the provisions of the Hatch act, nearly $750,000 a year in support of American agricultural experiment stations. That these stations have been the most potent factor in bringing about the recent great change is shown by the census returns. The value of crops on American farms in 1900 was about 48 per cent greater than in 1890. This large increase in the value of soil products is largely due to the more careful selection of plants and animals, to the prevention of disease and to the better methods of culture. In all of these improvements which have resulted in an annual net gain to the nation of several billion dollars a year, the Department of Agriculture and the State experiment stations, which form a part of it, deserve a share in the credit.

That the investigations of these institutions have proved beneficial is favorably shown by the action of so many State Legislatures in voting money to assist them. Last year the Agricultural Experiment Station of Illinois expended, in addition to the regular Government allowance of $15,000, a considerable sum appropriated by the State. The various amounts of these grants and the specific purposes for which State funds were appropriated are as follows:

For live stock investigations	$25,000
For soil investigations	25,000
For corn investigations	10,000
For horticultural investigations	10,000
For dairy investigations	15,000
Total	$85,000

Was it wisdom on the part of the Legislative Assembly of Illinois to grant $85,000 to be expended in one year in making scientific experiments in agriculture? A brief consideration of the item of $10,000 for corn investigations may aid in finding the proper answer to this question. In 1902 the State of Illinois had nearly 10,000,000 acres in corn, which produced 372,000,000 bushels, valued at $134,000,000. If we assume that as a result of careful selection and breeding a kind of corn can be produced which will yield two bushels more per acre than the common kind, the gain to the State is over $7,000,000 on one corn crop. It has been clearly demonstrated that it is not only possible to increase the yield, but to improve the quality. Men know in a general way the many points of difference between the scrub steer and the pure-bred Hereford. As a result of the far-reaching experiments of such men as Luther Burbank, of Santa Rosa, Cal., we are beginning to realize that the cultivated plants are as plastic as clay in the hands of the potter. "There is not a weed or flower," says Mr. Burbank, "which will not, sooner or later, respond liberally to good cultivation and persistent selection."

If California is to rank high as an agricultural State and keep the pace set by the rich farming States of Minnesota, Iowa, Illinois and Ohio, more money must be spent in agricultural education and in scientific experiments for the benefit of the farmers. The last Legislative Assembly made the following appropriations for the biennial period ending May 30, 1905:

Protection of viticulture interests	$ 3,000
Establishment of a poultry station	5,000
Ascertaining the best methods of using and distributing water	10,000

The last named item was to be expended in conjunction with a like sum from the irrigation investigations of the United States Department of Agriculture in coöperative irrigation experiments.

In other ways the last Legislative Assembly was quite liberal. The sum of $15,000 was appropriated to be expended with a like sum by the Bureau of Forestry in determining the forest resources of the State, while

$35,000 was voted to aid the director of the United State Geological Survey in making topographic maps, gaging streams, surveying reservoir sites and the like. The money derived from the sale of Government lands in California may likewise be used for the survey and construction of irrigation works, and for the three years ending December 30, 1903, this fund amounted to $1,287,119.

Few will question the wisdom of these appropriations for forestry and land and water surveys, as well as the building of large storage reservoirs by the Federal Government. At the same time, every fair-minded person must admit that these expenditures, although of great value to the future welfare of the State, are of practically no immediate benefit to the present owners and occupants of farms, orchards and ranches of California. It is, however, this class of citizens which provide by far the larger part of the revenues of the State, and it is asking no more than common justice that in granting funds for the development of agriculture their needs be carefully considered.

We have endeavored to plan the irrigation investigations now being carried on jointly by the State of California and the United States Department of Agriculture for the benefit of the irrigator. How far we have succeeded in accomplishing this purpose is a matter for you to decide after having heard the following brief report of the different lines of work that have been taken up:

SEEPAGE LOSSES IN IRRIGATION.

Irrigation enterprises have interfered with natural conditions. Before irrigation was practiced in California the water which escaped by gravity from the mountain slopes flowed in natural channels to the ocean. Now, in many sections, such as the San Joaquin Valley, much of the natural flow is diverted during the period of irrigation and spread over the surface of cultivated lands. If this were done in such a manner as to avoid loss there would be no seepage. Unfortunately over 90 per cent of the ditches and canals in Western America are built in earth, and the loss by sepage is, in many cases, very great. As a result of measurements made on canals and laterals in arid America during the past five years under the supervision of Prof. Elwood Mead, the loss on conveyance is estimated to be 40 per cent. When one considers that there is an additional waste of water in its application to the surface of fields, it will be apparent to all that as a rule less than one-half of the water which is now diverted through headgates is put to beneficial use. In other words, the water which is now used on 9,000,000 acres would suffice to irrigate 18,000,000 acres if all losses and waste could be prevented. It is not practicable to prevent all of this loss, but it would prove a paying investment in most cases to expend more money in improving canal channels, as well as the surface of irrigated fields. Improvements of this character are seldom made until the owners possess definite knowledge of present losses. A part of the money appropriated by both the Federal and State Governments to investigate irrigation in California has been devoted to this purpose. Typical canals in both the Santa Clara and San Joaquin Valleys are being measured to determine this loss.

Some five years ago Director Carpenter, of the Colorado Experiment Station, estimated the financial loss to that State from this cause to be $8,000,000 per annum. Owing to better methods of irrigating and to the costlier structures in use in Southern California the loss in this State is considerably less. There is, however, ample opportunity for improvement which will save vast sums in water which is now wasted.

It is our intention, if the funds at our disposal will permit, to make experiments on the cost and efficiencies of different kinds of suitable linings for ditches and canals.

IRRIGATION DISTRICTS OF CALIFORNIA.

Whether the Wright irrigation district law is good or bad is not now a vital question. Districts have been formed to the number of fifty, a large portion of the best irrigable lands and available water supplies have been included within these organized limits, and the large majority, for reasons that are well known, have not been successful. Little benefit will accrue, we believe, from a further discussion of the causes which led to these failures. Our plain duty is to unite in an effort to change failures into successes. This change is being rapidly accomplished by the people of the Modesto and Turlock districts. Last year the area irrigated in the two districts was about 12,000 acres; this year the area will be increased to from 25,000 to 30,000 acres. At this rate it will not take long to reclaim the 250,000 acres of fertile lands of both districts. When this is accomplished it is no exaggeration to state that the value of crops produced by irrigation will exceed those from dry farming by $5,000,000 a year. A community which is determined to accomplish this task deserves the encouragement of every citizen as well as the financial assistance of both State and Nation.

The completion of the Central Canal in the Sacramento Valley, which is now to be carried out, will add 150,000 acres to the credit of the Wright act and make a marvelous change in the population, taxable wealth and agricultural resources of the valley.

A part of our appropriation is being used to assist the people of the Toulumne districts. Water registers have been installed on each canal just below the La Grange dam to keep a continuous record of the flow; the duty of water and seepage losses will be determined and a study made of the best methods of water delivery under the district law, the proper preparation of land and its effect on crops.

The rise of the ground water level will also be observed and recorded in order that measures may be taken to drain certain portions before any injury is done to the crops. These studies and examinations of representative districts may prove valuable to other districts that are less advanced.

PREPARING LAND AND APPLYING WATER.

Another portion of our vailable funds has been expended in ascertaining the different methods employed in preparing land; the cost of each method has been discussed and compared, and the most efficient implements described. This information has been collected and compiled and is now in the hands of the Government printer. It is hoped that a practical bulletin on this subject will be of some use to every irrigator. It will enable those who are familiar with the methods in vogue in their vicinity to compare them with others practiced elsewhere, and it is believed that it will assist the new beginner on an irrigated farm in making a proper choice of the methods best adapted to his local conditions.

RESULTS OF IRRIGATION IN FRUIT RAISING.

In order to develop the practical point of view in defining results attained in the use of irrigation in fruit growing, a special inquiry has been pursued during the current year. A brief schedule was prepared, presenting a few leading questions and asking for the experience and observation of fruit growers in all the irrigated districts of the Pacific Coast. The special points covered were: Comparative amount and regularity of crops of fruit, with and without irrigation; comparative size, aroma and general appearance of fruit; experience in shipping, canning and drying fruits grown with and without irrigation; instances of injuries to trees or vines by drouth or by irrigation, etc. Very full responses have been received from these questions and are now being compiled for publication. By this phase of the work it is aimed to appeal directly to agriculturists who prefer the personal testimony of experience to the results of special experiments, or at least are attracted to the advantages of systematic experiments by the word of their friends that it "really works that way." At the same time the declaration of about 250 practical irrigators on a few specific points submitted to them may have an important suggestive relation to the work of the systematic investigation.

DRAINAGE.

In many sections of California irrigation can not be practiced without resorting in time to drainage. At first a naturally deep, dry soil absorbs all surplus and waste waters, and in this way injury to cultivated plants is avoided, but sooner or later there comes a time when provision must be made to remove the surplus by drains and pipes. Drainage has already become the vital question in the older irrigated sections of the San Joaquin Valley, and also in the more limited areas of such places as Riverside, Westminster and Oxnard.

The seepage from the irrigation canals and the waste from irrigated areas have been the chief cause of damage to such lands. No description can here be given of the 1,750,000 acres bordering on the Sacramento and San Joaquin Rivers which require drainage from natural causes.

In the past few years the work done in California by Mr. Mead and his assistants has included preventive as well as remedial measures. It has been shown that the cost of drainage in irrigated sections can be materially lessened by a more careful study of water. In other places observations are being made on the rise of the ground water level so that timely warning may be given to the farmers, either to apply less water or to prepare for drainage. Plans and estimates of cost of draining large tracts have also been prepared and submitted to the farmers whose lands were being damaged.

DUTY OF WATER.

The quantity of water applied to the land under several canals was measured last year. Similar work has already been done this season on the Modesto and Turlock irrigation districts. In addition to this, weir boxes have been inserted near the discharge pipes of a considerable number of pumping plants in southern California and in Tulare and Santa Clara Counties for the purpose of measuring the quantity of water used in orchard irrigation.

TANK EXPERIMENTS.

In addition to the ordinary duty, or service, of water, experiments are being carried on in four widely separated districts of the State to determine the right amount of water to apply to different crops, the rate of evaporation from soil surfaces, the effect of shallow and deep furrows and other problems related to soil moisture and the growth of plants.

PUMPING WATER FOR IRRIGATION.

This is a new branch of irrigation, and the ordinary farmer, or water user, under a gravity canal has had little opportunity of gaining information concerning it. During the past few years many pumping plants have been installed and much experimenting has been done at the expense of the owners, but the experience and knowledge thus gained by the few have not been available to the many. A study of the cost and methods used in pumping water forms an important feature of the coöperative irrigation investigations. This branch of the subject is many-sided. There are, for example, a comparison of the various fuels, the proper conditions for each kind and make of pumps and engines, under which both will work at their highest efficiency, the digging and boring of wells, the proper installation of plants, the effect of pumping on the ground water supply and the quantity required for the different crops of soil of various character. These and similar questions have been investigated during the past year and the information obtained will be embodied in a publication to be issued next fall.

WHEN ACORNS FALL.

When acorns fall and swallows troop for flight,
And hope matured slow mellows to regret,
And autumn pressed by winter for his debt,
Drops leaf on leaf till she is beggared quite;
Should then the crescent moon's unselfish light
Gleam up the sky just as the sun doth set,
Her brightening gaze, though day and dark have met,
Prolongs the gloaming and retards the night,
So, fair young life, new risen until mine
Just as it owns the edict of decay
And Fancy's fire should pale and pass away,
My menaced glory takes a glow from thine,
And, in the deepening sundown of my day,
Thou with thy dawn delayest my decline.

—*Alfred Austin.*

THE SITUATION IN A NUTSHELL.

Under the act of June 4, 1897, known as the lien-land forest reserve selection act, many millions of acres of scrip were authorized. This scrip may be located on any public lands of the United States. Application for more than 3,000,000 acres under this scrip have already been filed in the general land office. The repeal of our land laws would naturally enhance the value of the scrip, which is held exclusively by two or three corporations, and this is the reason why Hot-Air Maxwell has been so busy trying to set aside the laws. We have always contended that it is not wise to reverse our land policy. We rather should find the defects in existing laws and remedy them.—*Denver Field and Farm*, December, 1903.

The Los Angeles *Times* bewails the failure of Congress to comply with what it is pleased to term "the universal demand of the West for the repeal of the land laws." The universality of the Western demand for the repeal of the land laws is confined to the columns of the *Times* and the Maxwell gang.

CANAL AND STREAM MEASUREMENTS.*

BY A. P. STOVER.
Instructor in Irrigation, University of California.

As one comes in contact with irrigation practice in the West, among the first features to attract attention is the almost universal ignorance of the average irrigator as to the exact amount of water he controls. It is true that he has an idea of how much water is required to satisfy his needs, but to reduce this amount to tangible units is an utter impossibility. His gauge is his eye, aided by his judgment sharpened by constant practice. We may say that all irrigators know when their water supply is short, a comparatively small number know when they have too much, but the percentage who can tell when they are receiving and using the right amount of water is very small.

Where the value of agricultural land is gauged by the water supply available for use thereon, it would seem that a man's water supply should be measured and divided as accurately as is the land whose producing value it regulates. The average irrigator, if he wishes to know the area of a tract of land, takes a tape line and measures its boundaries and dimensions. He can, with little difficulty, compute the volume of water in his reservoir, but when it comes to determining the discharge of his irrigation stream he too often is contented with a mere guess, or relies upon the statement of some one who is probably no more competent to judge than himself.

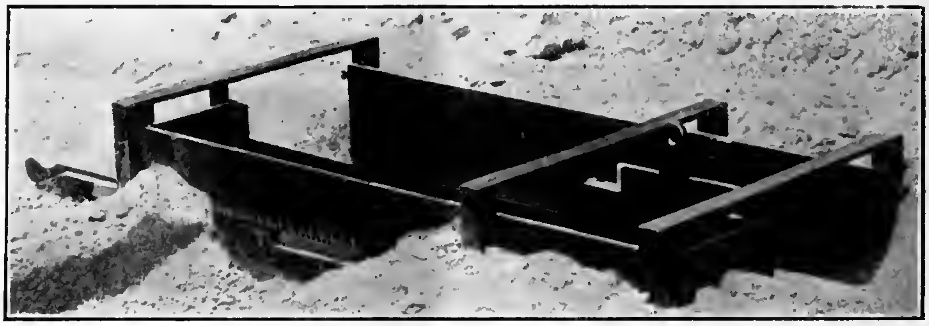


Fig. 1. The Foote Modification of the Miner's Inch-box.

To those unfamiliar with the operation, the measurement of a stream of flowing water seems quite a complicated and difficult problem. It is but another case, however, where appearances are deceiving, for the operation, when understood, is found to be a comparatively simple one. The two methods of measuring water to be described—viz., by the measuring weir and by the current meter, are those most commonly employed by engineers and others required to control, regulate, or divide flowing water.

UNITS USED IN EXPRESSING STREAM DISCHARGE.

The discharge from pumps and from wells is usually expressed in gallons per second, minute or hour. From ditches, canals and streams, however, the gallon is too small a unit and for these the discharge should be expressed in cubic feet per second or in cubic feet per minute, these units being abbreviated often to second feet and minute feet respectively. In addition to these units of flow the "Miner's Inch" is frequently used.

This method of measuring water by "inches" had its origin in the early days of hydraulic mining. The miner's inch box consists essentially of a rectangular box, having a slot in one side through which the water is allowed to escape under a low pressure. With given conditions satisfied relative to the size of the slot, to the head of the opening and to the flow of the water from the orifice; the number of square inches of opening is the number of "inches" being discharged brom the box. A number of States, California among the first, adopted the miner's inch system as the legal method of measurement and the statutes prescribed the conditions under which the measurement should be made.

Colorado law defines the "inch" and prescribes the conditions to be observed in measurement as follows:

"Every inch shall be considered equal to an inch square orifice under a five-inch pressure, and a five-inch pressure shall be from the top of the orifice * * * to the surface of the water. * * * Slot or aperture through which the water may be measured shall in all cases be six inches perpendicular inside measurement except in boxes delivering less than twelve inches which may be square. * * * Box shall have a descending grade from the water in the ditch of not less than one-eighth of an inch to the foot."

In most instances the six-inch slot has been prescribed, and the head required varies from four inches above the center in some States to six inches above the top of the orifice in others. Because of this wide variation in the conditions required, not only by statute, but by custom as well, the use of the inch as a unit of measurement is to be deprecated. Its value varies quite widely in various States as shown in the following table.

Table showing number of inches assumed to be equal to a flow of one cubic foot per second in different Western States:

	By Custom	By Statute
Equivalent in California	50	40
Equivalent in Colorado	38.4	38.4
Equivalent in Montana	40	40
Equivalent in Idaho	50	
Equivalent in Arizona	40	
Equivalent in Nevada	50	
Equivalent in Utah	50	

Not only does it vary in different States, but it also has different value in some instances in the same State. For instance, in Nevada the inch in one part of the State may be measured under a four inch pressure, while in another part of the State it is measured under six inch or twelve inch pressure, depending entirely upon local custom. An investigation of the irrigation practice on the Humboldt River,* revealed the fact that not only did the pressure vary between these limits, but in some cases water was measured under pressures of two feet, three and one-half feet and four feet.

*Courtesy California Journal of Technology.

*Report of United States Irrigation Investigations, Humboldt River Valley, by J. D. Stannard, 1901.

In California the equivalent of the inch in common usage in the southern part of the State is one-fiftieth of a second-foot, while in the statutes of California* the equivalent is laid down as one-fortieth of a cubic foot per second.

The reader will readily see that the conditions governing the volume of an "inch" are so numerous that a discrepancy might very easily creep into the measurement of a stream by this method, even though much care be exercised. Not the least among the many difficult conditions to fulfill is to maintain a constant head over the orifice. Former State Engineer of Idaho, Mr. A. D. Foote, designed the measuring box shown in Fig. 1, by means of which it was possible to maintain a fairly constant head on the opening. The flume structure is placed in the stream channel as shown and a portion of the flow is admitted to the chamber on the lower side of which is the measuring slot. The excess above the amount to be measured spills back into the main channel over the long crest, which is of sufficient height above the orifice to give the desired head. By regulating the flash boards in the main channel and the gate to the chamber, the approximate amount to be measured can be admitted;

Fig. 2. Trapezoidal Weir-box.

then should any variation occur in the flow in the main channel, the long crested weir prevents any excessive increase in head on the orifice. The Foote box, when properly installed, gives quite satisfactory results in the measurement of small streams.

The most serious fault to be found with the miner's inch system of measurement, however, is that its field of usefulness is limited to the measurement of a comparatively small volume of water. A stream of two or three cubic feet per second could be measured with ease, but a box to measure the flow of one of the large canals of the State carrying, say, 600 cubic feet of water per second, would, if all conditions were observed, require a six-inch slot nearly 417 feet long, which would be practically impossible.

THE MEASURING WEIR.

By far the most satisfactory and accurate method of measuring small streams, where all the conditions imposed can be fulfilled, is by means of a weir. The ones most commonly used in irrigation practice are the rectangular weir and the Cippoletti or trapezoidal weir. Both take their names from the shape of the notch through which the stream of water is discharged. In Fig. 2 is shown a weir-box having a trapezoidal weir notch while Fig. 3, a section passed longitudinally through the weir-box, shows the manner in which the water flows over the crest "C." The theory upon which the formula for expressing the discharge is based is quite similar for the two forms of weirs. It is, however, not within the province of this paper to take up the theory of weir discharge. Suffice it to say that the weir notch is considered as a large orifice through which the water flows. The head, on the bottom of this orifice, is equal to the depth of water flowing over the crest, while the head on the top of the orifice becomes zero by virtue of the position of the notch.

The formula for expressing the discharge over rectangular weirs having complete end contractions was developed by J. B. Francis, in 1854, from an exhaustive series of experiments made at Lowell, Mass. As commonly written it is,

$Q=3.33(L-.2h)h^{3/2}$

In this Q is the discharge in cubic feet per second and h is the head of water on the crest which is measured in feet some distance back of the weir plate as shown in Fig. 3, L is the length of the weir crest in feet, while 3.33 is a constant derived by experiment.

The formula for the trapezoidal weir as derived by Cæsare Cippoletti, in 1887 is,

$Q=3.367\ (Lxh^{3/2})$

In this Q, h and L represent the discharge, head on crest, and length of crest as in the Francis formula.

While the discharge over either form of weir may be computed by the formulæ just given, it is not entirely necessary, however, as weir tables may be had which have been computed by these formulæ and which give the discharge for any depth over weirs varying in length from one to twelve feet.

By observing the following instructions regarding the installation and operation of either of the weirs just named, one may be confident that the error in measurement will not be greater than one per cent. The conditions as here given are taken from Prof. L. G. Carpenter's valuable paper on "Measurement and Division of Water," which appeared as Bulletin No. 27 of the Colorado Experiment Station in 1894.

CONDITIONS FOR THE WEIR, EITHER RECTANGULAR OR TRAPEZOIDAL.

1. That the channel leading to the weir be of constant cross-section, its axis passing through the middle of the weir and perpendicular to it. This straight reach to be of such length that the water flows with uniform velocity, without internal agitation or eddies. This should be not less than fifty or sixty feet, more if possible.

2. Only by making the contraction complete on both sides and bottom can the constants in the formula have a value free from uncertainty, and to secure complete contraction, it is necessary:

a. That the opening of the weir be made in a plane surface, perpendicular to the course of the water;

b. That the opening itself have a sharp edge on the upstream face, and its walls cut away so that their thickness at the point of discharge shall not be above one-tenth the depth for depths below five inches, nor

*Statutes of California (approved March 23, 1901) Sec. 1. The standard miner's inch of water shall be equivalent or equal to one and one-half cubic feet of water per minute (.025 cubic feet per second), measured through any aperture or orifice.

above one-fourth the depth for depths from five to twenty-four inches;

c. That the distance of the sill of the weir from the bottom of the canal be at least three times the depth on the water;

d. That the distance of the sill of the weir from the sides of the channel be at least twice the depth of the water flowing over the weir;

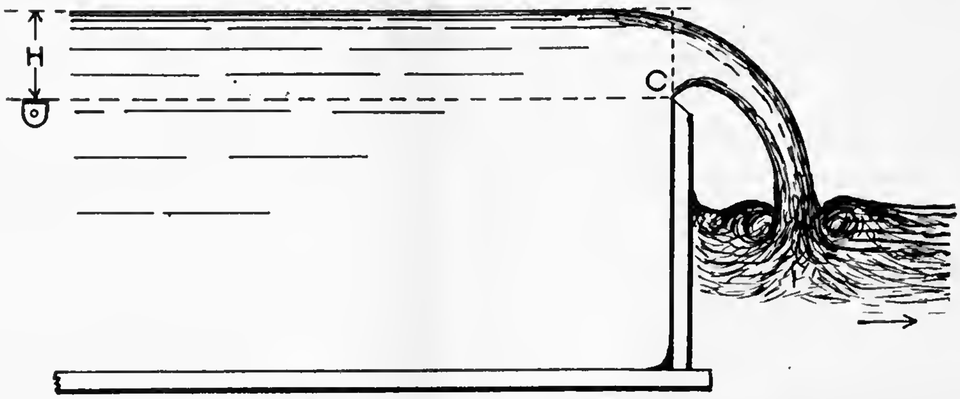


Fig. 3. Longitudinal Section Through Weir-box.

e. That the lateral contraction remaining undisturbed, the length of the weir shall be three or, better, four times the depth of the water flowing over;

f. That the length of the water flowing over the weir shall not be less than two inches.

3. The velocity of approach must be very small; for weirs three feet long and depth of twelve inches, it ought not to be greater than six inches per second; for weirs of six feet long and depth of twenty-four inches it ought not to be above eight inches per second. In all these cases the cross-section of the canal of approach ought to be at least seven times that of the weir. Other conditions effecting the velocity are included in c, d, and e, respecting complete contraction.

4. The layer of falling water should be perfectly free from the walls below the weir, in order that air may freely circulate underneath. For short weirs it is sufficient that the lateral walls of the lower canal be free from the sides of the weir. In such case, when air freely passes underneath, the level of the water in the lower canal has no influence on the discharge of the weir, unless it reaches or exceeds the level of the crest.

5. The depth of the water should be measured with accuracy where the suction of the flow does not affect the height and where it is free from the influences such as the wind, or the movement of the water which can effect the true level. The height should be read to within one-three hundredth of the depth in order that the error may be within one-half of one per cent.

6. The weir ought to be constructed with care and carefully located. It should not vary more than four degrees from being perpendicular to the channel. Its sill should be horizontal.

THE CURRENT METER.

To use the weir as a measuring device, it is necessary, as has been seen, to obstruct the channel and interfere with the free flow of the water. Obviously this can only be done where the stream is of comparatively small size. The large canal and natural stream are without its sphere of usefulness, unless costly works can be employed. For the larger streams, therefore, say where the discharge exceeds 40 cubic feet per second, by far the more practical method of obtaining the discharge is by use of what is called a current meter which, as its name implies, is a measurer of the current or velocity of flow.

The instrument consists essentially of a metal frame in which is pivoted a small paddle wheel which turns on its axis with but very little friction. The theory of its operation is that when immersed in moving water there is a mathematical ratio betwen the velocity of the flow of the stream and the velocity of the revolution of the vane. This relation may be represented by an equation

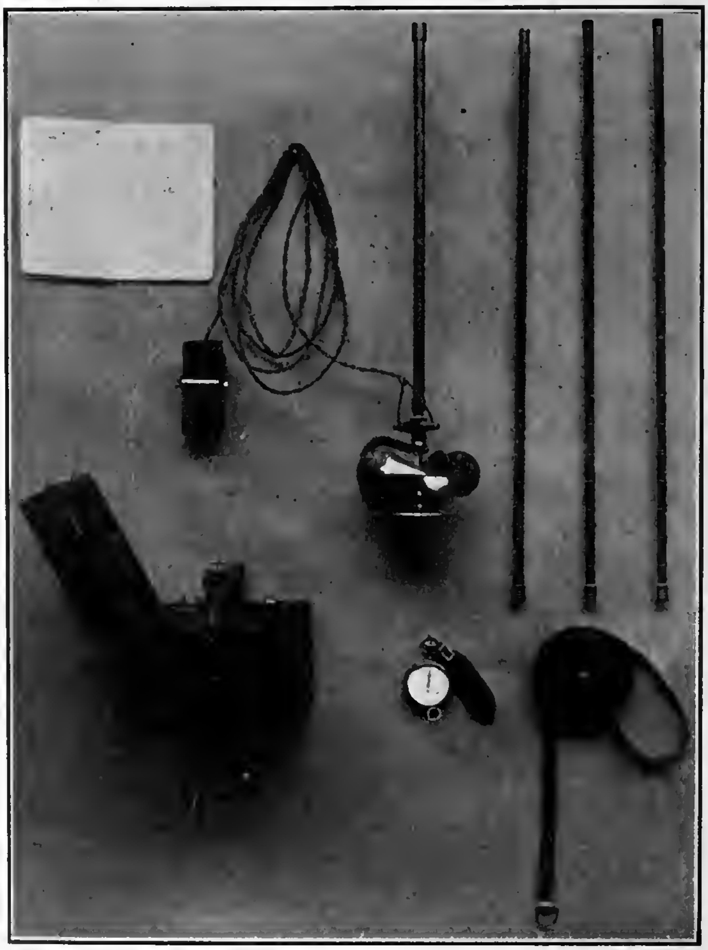


Fig. 4. Small Electric Current Meter and Outfit.

which, as the friction in the instrument becomes less, approaches the equation of a straight line.

To obtain the velocity of any stream it is necessary,

therefore, to know, for the particular meter used, the relation of its velocity of revolution to the velocity of the stream's flow, or, in short, to know the meter's equation, or rating, as it is commonly termed. Before proceeding, however, to a description of the method of rating the meter it will be well to describe with some detail the mechanism of the meter itself. From what has been said it will be seen that it is necessary by some means to keep tally on the number of revolutions the vane makes when immersed in flowing water. This is accomplished in a variety of ways, depending upon the style or type of meter used. In Fig. 4 is shown a small sized current meter, suitable for measurement of all sized canals and for medium sized streams. The meter here shown has the vane mounted on a vertical axis, which at its upper extremity is made eccentric so that during a portion of each revolution of the wheel the eccentric portion of the shaft comes in contact with a fine steel spring, and thus makes an electrical contact. By means of an electrical buzzer or register, properly connected in circuit with the steel spring and meter frame, the revolutions of the vane may be counted by the observer. In the figure the electric buzzer is shown connected to the two binding posts of the meter. There are other forms of electric current meter, some having horizontal axis and provided with a helicoidal shaped vane instead of the cup vane. For large river work the meter is made much heavier and stronger throughout, in order that it may withstand the shock and strain without being damaged. In addition to the electric pattern there are what are termed acoustic current meters, in which the revolutions of the vane are indicated by a mechanism which taps on a small metallic drum every tenth revolution, the sound being transmitted through the meter rod and a rubber tubing connection to a receiver placed to the observer's ear. Then, also, there are self-recording current meters in which the vane engages, by a system of gears, with a set of index wheels from which the revolutions may be read directly.

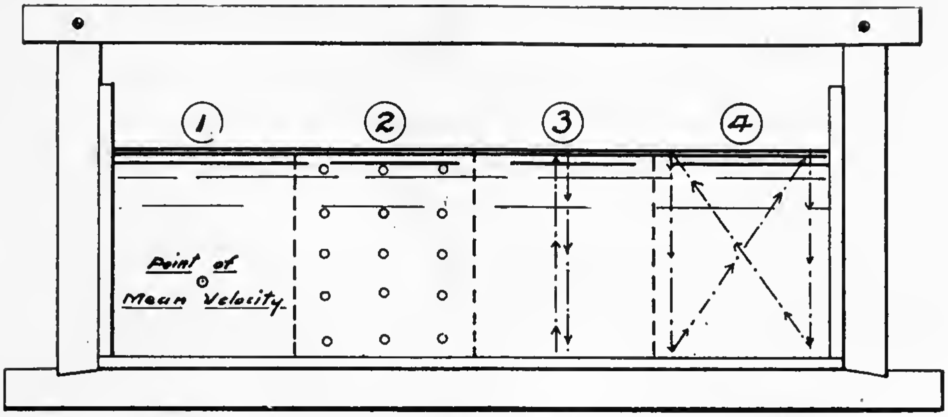
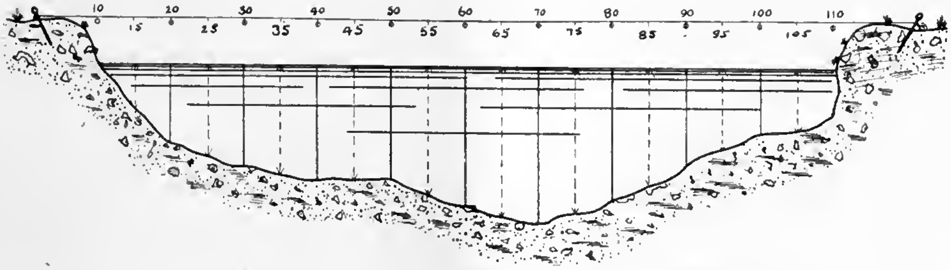


Fig. 5. Flume Cross-Section, Showing Methods of Manipulating Current Meter.



Section of 100 Foot Stream Showing Method of Division Into Small Sections.

RATING THE CURRENT METER.

The equation of a meter is determined by attaching the instrument to the prow of a rowboat, or to specially constructed float or car and moving the vane through still water at various rates of speed; varying from three-tenths feet per second to ten or twelve feet per second. The observations are then platted on co-ordinate paper with the velocity in feet per second as ordinates and the revolutions of the vane per second as abscissae. For such an instrument as the one illustrated, the curve connecting the platted points will be practically a straight line, whose equation may be easily determined. By using the equation or by reading directly from the curve, a rating table may be constructed showing the velocity corresponding to any number of revolutions per second. The table is then ready for use in calculating the results of a stream measurement.

USING THE CURRENT METER.

To determine the discharge in any channel two things must be determined: first, the sectional area of the stream at the point of measurement, and second, the velocity with which the water passes through different portions of this cross-section. The former can be determined by direct measurement, as will be presently described. The latter must be determined by means of the current meter, or some other means, such as floats. The velocity in any cross-section, as we all know, varies widely at different points. In the center of the stream the velocity is much greater than along the banks or bed. To obtain, therefore, an expression which shall represent the mean velocity throughout the section it is necessary that observations be taken at various points. In practice the mean velocity is not determined for the stream as a whole, but the cross section is sub-divided into small sections in which the velocity and discharge are determined independently, the total flow of the stream being represented by the sum of the discharges in the smaller sections.

In choosing a point of measurement on a canal,

other things being equal, the measurement should be made in a section where the velocity of flow is quite uniform, where the channel is straight and banks free from indentations. Measurements made in flumes which are in good order are, as a rule, more accurate than those made in the natural channels. Whether the channel be a flume or an earthen section, the measurement should be made where the bottom of the channel is on or slightly above the general grade of the channel. An accurate measurement can not be made where there is dead water space in the section.

The various ways in which the meter is manipulated in determining the mean velocity of a section are shown in Fig. 5. Sections 1 and 2 represent the Point method. Sections 3 and 4 represent the Intergration method.

THE POINT METHOD.

Section 1.—The meter is held at one point in the section at which it is supposed or assumed the velocity is the mean of the entire section. Where the flow in the section is uniform, as in the case of the flume under consideration, this point will be found at the center of each section and at a point about six-tenths of the depth below the surface. It will be seen that by using this method but little time is required to determine the mean velocity in each section, but that the accuracy of the measurement depends upon the success with which the point representing the mean velocity is chosen.

Section 2.—A more accurate result will be obtained, if, instead of determining the velocity at one point in each section, observations be taken at a number of points in a section. These may be located at intervals in a vertical line through the center of the section or may be taken at random over the entire area of the section. Either method will give accurate results, depending, of course, upon the number of observations made.

THE INTEGRATION METHOD.

Section 3.—The most common way of taking observations is to slowly move the meter up and down on the center line of the section during the period of observation. In this way an integrated value representing the mean velocity of the section is obtained. The mean velocity of the section may also be determined by slowly moving the meter in a zig-zag path over the entire area, as shown in Section 4. In any measurement, the same method, of course, should be used for all sections.

In dividing the cross-section of natural channels into sections much more care is required than where the measurement is made in a flume; for in the open channel the beds and sides of the channel being more uneven in character cause the motion of the water to be much more disturbed. As the variation velocities between the center and the side in the natural channel is much greater than in the flume the sections generally should be made smaller and their area determined with greater care.

Method of Measuring Stream Flow by Wire Cable and Car.

MAKING A MEASUREMENT OF A STREAM IN NATURAL CHANNEL.

The observer, having chosen the point at which a stream is to be measured, proceeds in the following manner to determine its discharge. Wherever possible, some structure, such as a bridge, plank, or log, is used as a platform from which the observations and measurements are made. Where the stream is small and great accuracy of measurement is not required the observer may get along without such a structure by simply wading in the stream. Where this, however, is done, it is very neces-

sary that the obstructions of the flow caused by the observer's body shall not interfere seriously with the current acting upon the meter. For large streams where a structure is not available and where the water is too deep or the current too strong for wading, a wire cable is stretched across the stream and by means of a car suspended from it the observer is enabled to make the measurements at the various points in the cross-section. Whatever be the means of spanning the stream, the first thing the observer does is to stretch his tape, chain or tag wire across the channel and divide the stream into sections whose sides depend upon the accuracy of the measurement desired. In Fig. 6 is shown the cross-section of a natural channel with the tag wire stretched and sections outlined as above suggested. The stream, in this instance, is taken as being 100 feet wide and ten foot sections have been chosen and represented by the tags on the chain. Beginning at the left bank, which is taken as station 10, the observer measures the depth of water at the edge. Then the depth at five feet is taken, which is assumed to be the average depth of the first section. The center depths of the remaining sections are then taken in successive order and recorded in the note book, in a column headed "Depths." Having measured the depth of each ten foot section he next proceeds to obtain the mean velocity of flow in the respective sections. This, if the vertical integration method is used, is done by taking observations at the same points at which the depths have been measured. He immerses the meter at Station 5, and waits until the motion of the vane has become uniform and the flow of the water undisturbed, then simultaneously with the sound of the buzzer the stop watch is started and the meter gradually lowered until it reaches the bottom of the channel. then changing the direction it is moved upward with a uniform motion until the starting point is reached. The observer continues this vertical motion usually for fifty seconds. The fifty second period is chosen for ease in computation of the results. To determine the number of revolutions per second made by the vane where the fifty second period is used it is only necessary to multiply the total number of revolutions by two and point off two decimal places. The number of revolutions made at the center of each section is recorded in the note book as shown. This completes the notes of the observation and they are now ready for computation.

GAUGING OF GALLATIN RIVER AT SALESVILLE, MONT.

Date June 3, 1902. Gauge Height 7.4.

Station	Depth	Time	Revolutions	Revolutions per Second	Velocity	Area	Discharge
10 Left Bank							
15	1.0	50″	30	.06	1.85	10.0	18.5
25	2.3	50″	35	.70	2.08	23.0	47.8
35	2.9	50″	43	.86	2.45	29.0	71.0
45	3.0	50″	50	1.00	2.82	30.0	84.6
55	3.4	50″	60	1.20	3.31	34.0	112.5
65	4.0	50″	65	1.30	3.55	40.0	142.0
75	4.0	50″	65	1.30	3.55	40.0	142.0
85	3.5	50″	48	.96	2.70	35.0	94.5
95	2.0	50″	40	.80	2.33	20.0	46.6
105	1.6	50″	37	.74	2.20	16.0	35.2
110 Right Bank							
							794.7

Meter No. 112.

PAGE OF FIELD NOTE BOOK.

Computation of field notes. The figures in the first four columns represent the observations taken in the field. In column headed "station" are given the points in the cross-section at which the depths of sections recorded in the second column and meter observations recorded in the fourth column have been taken. In computing the discharge, the number of revolutions made per second by the meter are placed in the fifth column. From the rating table of the meter a mean velocity of flow for each section corresponding to the revolutions per second observed are placed in the sixth column, headed "velocity." The width of each section in the case under consideration is ten feet. This multiplied by the mean depth of each section gives the area in square feet, which is placed in the seventh column. Not knowing the area and corresponding mean velocity of each section, the product of the two gives us the discharge, which is placed in the last column. The sum of the several discharges is the total discharge of the stream. The method of recording notes varies, of course with the style of meter used and with the way in which the velocity is determined.

From what has been said, it will be seen that the accuracy of current meter measurements depends primarily upon the accuracy of the meter rating. It also depends upon the care and the manner in which the meter is used and upon the conditions of flow in the channel measured. Other conditions being equal, the best results will be obtained where the measurement can be made in the section of greatest uniformity. For this reason, the rating flume should be used wherever possible and wherever a record is to be continued on a canal or stream some means should be adopted to obtain a uniform fixed channel. In a few of the Western States laws require that all irrigation canals and ditches shall install properly constructed rating flumes near their respective points of diversion.

KANSAS VS. COLORADO.

Senator Smith Spoke of the Law-suit and What It Means for Kansas.

At the irrigation convention held at Garden City, Kan., in December, Senator F. Dumont Smith, of Kinsley, one of the counsel for Kansas in the suit of Kansas vs. Colorado, explained the objects and status of the case. This suit was brought by the State at the urging of the people in the Arkansas Valley around Wichita and Arkansas City, who believed that since the extensive practice of irrigation in Colorado the water in the Arkansas and the underflow was greatly decreased. Such a case is unprecedented. The contention of Kansas is under the old common law doctrine of riparian rights, that the lower properties on a stream had a right to have the water flow as accustomed except for domestic use, the proprietor above not being allowed to prevent or contaminate the water. The Colorado contention conceeds the common law position of Kansas but holds that owing to necessity this principle has been superseded in arid regions by the theory of prior appropriation, that the man who first takes out the water for irrigation has the first right to it. This doctrine prevails in all the Western States and is recognized by the constitution of Colorado, and was agreed to by the United States when Colorado was admitted with that constitution. Under this theory Colorado claims the right to every drop of water in the river. Colorado further claims that irrigation in that State does not injure Kansas.

THE SCOPE AND PURPOSE OF THE IRRIGATION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

BY ELWOOD MEAD, IRRIGATION EXPERT IN CHARGE.
Courtesy U. S. Department of Agriculture.

With relation to rainfall the territory of the United States is divided into three parts—the humid, the subhumid and the arid. In the humid region the rainfall is ordinarily abundant, but there are occasional seasons when it is insufficient for the raising of crops, and in most seasons there are times when crops are checked in their growth by periods of drought lasting from a few days to a few weeks. The subhumid region includes the territory where dry periods in summer are the rule. The injury to crops in subhumid regions is due to two causes—insufficient moisture and great irregularity in its distribution. The arid region includes the areas where cultivated crops can not be grown by the aid of rainfall alone.

Geographically, these regions are arranged from east to west, although no exact line can be drawn separating them. The humid region, as generally described, includes all of the United States westward to a line which would cross Nebraska and Kansas about halfway between their eastern and western borders. The subhumid region lies between the humid and arid regions, extending from the Gulf of Mexico to Canada and including irregular areas in the different Pacific coast States: while the arid region includes all the territory lying west of the eastern subhumid belt with a considerable exception along the Pacific coast, and with smaller local areas in each of the arid States.

Irrigation is employed as an aid to agriculture in all of these regions. It is a necessity in the arid region, of great value in the subhumid district, and is proving highly profitable in the growing of certain crops in the humid region. There are also large areas in the recently acquired insular possessions of the United States where irrigation is required, and where the value of the products permits of a large outlay to provide for its use. The work of the irrigation investigation of the Office of Experiment Stations covers, therefore, the whole of the United States.

Irrigation Investigations—Measuring Station on Jackson Lateral, Laguna Canal, Rockyford, Colorado.

INVESTIGATIONS IN THE ARID REGION.

The greater part of the irrigation work of this office has been carried on in the region where farming is impossible without the artificial application of water to crops. This includes all of the Territories of Arizona and New Mexico, the States of Colorado, Utah, Nevada, Montana and Wyoming, and large parts of California, Oregon, Washington, Idaho, North Dakota, South Dakota, Nebraska, Kansas and Texas. The greater attention paid to the problems of this section of the country is justified by the fact that here irrigation is a necessity rather than a valuable adjunct to agriculture. It measures agricultural settlement and very largely controls the development of other industries, because both the cost and comfort of living are very largely determined by the production of a home food supply. In the regions farther east, the adoption of irrigation is determined by whether or not it will improve conditions already favorable, but in the arid region it is the choice between civilization and desert condtion.

The work in this region has followed two general lines—agricultural and engineering, legal and social. Of these, the legal and social problems present the

greatest difficulties and stand most in need of an early solution. The success of irrigated agriculture in this region requires first of all the creation of institutions which shall offer a just and adequate foundation for future development. Such a foundation requires that the users' rights to streams must be clearly defined in order that those who now use streams and those who expect to use them may understand how much of the water supply is appropriated and how much remains open to appropriation. The litigation and controversy which now menace communities and which are a constant source of anxiety and loss to irrigators should be brought to an end. In order to effect these desirable reforms, a knowledge of certain essential facts is required. Among these are the quantity of water required to grow crops, the losses from seepage and evaporation in distribution, the character of the control over streams already vested, and the kind of administrative measures needed to insure effective division of streams among the multitude of users who depend thereon. Specific information along these lines is indispensable to wise and effective action in the future either by the Government or by individuals. It is the information which should have been gathered at the very outset of this development, but the long delay in its collection renders it all the more urgent that it be carried on now to an early and effective completion.

The work along agricultural and engineering lines has been largely carried out in coöperation with the agricultural experiment stations of the different States, and with the State engineers in States having such officials. By undertaking systematic work on some of the general problems of irrigation, this office has been able to supplement and extend the work of the experiment stations, and at the same time has aided them to take hold of other studies, such as problems relating to the economical use of water on different crops. It makes possible the bringing together of observations from the whole country. It promotes uniformity of methods in these investigations and thus gives to the results a wider value than is possible with each station working independently and alone. It brings together the experience of the whole irrigated West for the use of each locality, and shows the farmers of one section where their practices can be improved by adopting those of other and oftentimes far distant sections.

AGRICULTURAL AND ENGINEERING PROBLEMS.

The studies of the practical questions involved in diverting water from streams, transporting it through canals and ditches, distributing it over the land, and determining the requirements of different crops have been carried on in all of the arid and semiarid States with one exception. In general, the results of this work show that the losses in distribution are much greater than has usually been supposed, and that the quantity of water required, where these losses are included, is somewhat greater than has been estimated by many writers on the subject or stipulated in many water-right contracts. The stations for the measurement of the duty of water are scattered over nearly one-third of the United States. The averages of the different measurements for the past two years show a surprisingly close agreement when this wide range of conditions is considered, as appears from the following summary:

Irrigation Investigations—Flume and Register Used in Measuring Irrigating Water.

	Feet.
The average depth of water applied to crops in 1899 was	4.35
The average depth of water applied to crops in 1900 was	4.13

One of the results of this work has been to show the importance of keeping canals in good condition, and to emphasize the benefits resulting from diminishing as far as possible the losses by percolation. Measurements show that the loss from seepage and evaporation in ditches and canals varies from 15 to 70 per cent of all the water taken in at their heads, and that by far the greater part of this loss is due to seepage. Formerly many believed that most of the loss was due to evaporation, and was therefore beyond the power of man to remedy. Now that it has been demonstrated that the water disappears through the sides and bottoms of ditches and canals, steps can be taken to improve these channels and the loss stopped to a great extent. Improvements of this character will increase the area which can be irrigated, and save much land for productive agriculture which would otherwise become swamps and marshes.

The difference between the high and low duties obtained under practically the same conditions shows that where water can be had in abundance the natural tendency is to use too much, resulting in a reduction in the yield of crops, a temporary injury to the land, and a limitation of the area which can be irrigated with the available water supply.

In many localities a lavish use of water has converted areas once arid into alkali marshes, of which the only product is cat-tail flags, and made drainage necessary at a cost fully as great as was required to provide the water supply in the first instance. The need of this drainage might have been avoided in many cases had canals been constructed with more care and the evil results of overirrigation appreciated at the outset.

The soils of the arid regions are rich in mineral ingredients. This is due in part to their origin and in part to the scanty rainfall, which has not been sufficient to wash out the soluble elements, as has been the case in humid regions. Because of this there are large areas which are highly charged with alkali. The tendency of irrigation is to leach these salts out of the higher grounds and concentrate them in the lower lands. Evaporation tends to bring them to the surface, where they accumulate in such quantities as to kill vegetation. The remedy is to be found in drainage, and this investigation has been called upon to assist in solving the larger engineering and legal problems connected with the formation of drainage plans. As some of these districts embrace in the aggregate many thousands of acres, in which not only the alkali but the water plane has risen until it has reached the surface, it is necessary that the plans should be comprehensive, and must include provision for removing the surplus water as well as the salts which are to pass with it. Drainage studies must include the causes of their being flooded and a determination of the source and volume of the water to be removed. Drainage and irrigation are a part of one whole, and their investigation should be carried on together. The office is now engaged in this work in Colorado and California.

The publication and circulation of the facts being gathered regarding the injuries resulting from excessive losses in distribution or wasteful use will go far to prevent a recurrence of such injuries in other localities where irrigation is yet in its infancy. Another result will be the reclamation of more land than would otherwise be possible.

(To be Continued.)

THE PRIMER OF IRRIGATION.

Chapter XIV.

THE SCIENCE AND ART OF IRRIGATION—INFILTRATION OR SEEPAGE.

(Continued.)

Irrigation by infiltration or seepage is effected, following the configuration of the soil, by means of flowing, or sleeping water seeping or soaking into the soil from ditches, canals, or other waterways at or beneath the surface of the land. The water spreads, soaks, seeps out fanlike into the soil from the sides and bottom of the ditch or canal, and descends in pursuance of the law of gravity, or ascends in accordance with the law of capillary motion toward the surface, where it evaporates unless its course is stopped by breaking up the soil.

Water descending by the force of gravity continues on until it meets with what is commonly called "ground water," with which it mingles. If it does not encounter ground water, or a water table, it expends its energy by descending as far as it can as water, then it is converted into moisture and begins making its way to the surface through capillary motion. Infiltration rests upon the principle of the permeability of the soil, and hence, this method of irrigation is not always so beneficial as those which have been already mentioned, for it consumes a large quantity of water without supplying the soil with a uniform humidity. There is this exception, however; when the flowing water in the trench, ditch, or underground conveyance reaches the intended root zone and there spreads out or seeps into soil where it can be directly utilized. This is one of the advantages of sub-irrigation, a system which can not be ignored for many reasons.

SUB-IRRIGATION.

Sub-irrigation is a variety of infiltration which possesses many advantages over surface irrigation where wastage of water is an object to be avoided. By this system, land too elevated to be reached through other means is transformed into fertility. In the case of hill land it is admirable for cereals, and also on lands where weeds abound. It lends an invaluable aid to special plant cultures, such as grapes, olives, oranges and citrus fruits generally, and in gardening. It enables steep lands to be cut into terraces which irrigation water could not reach or in which it could not penetrate to a sufficient depth. In addition to these advantages, the application of underground water to arid or waste land covered with gravel or sand, permits the propagation and cultivation of productive plants which would otherwise perish through dryness of subsoil. Finally, a well arranged system of sub-irrigation operates as a drainage system, and thus a double purpose is served.

The nature of the soil is of more importance than the configuration of the land in sub-irrigation. In this respect, hard, impenetrable soils, and those too open and porous should be avoided for general infiltration purposes. Experience alone is able to guide the irrigator in establishing any system of deep ditches, the main point to be attained is always to provide for moistening the soil uniformly.

FURROW IRRIGATION.

Applied to cultivated land, furrow irrigation is allied to infiltration. Running water into furrows between the rows of plants and then cultivating over is a very common method of irrigation by infiltration, and is suitable for all shallow rooted plants, corn, potatoes, and tubers generally. The after cultivation by which the surface soil is pulverized, forms a mulch which retains the moisture below for a long period. It is also adopted on a large scale in orchards, vineyards, and nurseries; for small fruits, vegetable and flower gardens, wherever, in fact, deep irrigation or sub-irrigation, flooding, or flowing would be useless, or inefficient. It is well to provide that the water or surface wet be prevented from spreading as far as the stalks or bodies of the plants, for that means rotting, restricting it to the service of the roots. This renders this method of irrigation more efficacious than direct irrigation for the reason that the humidity is imprisoned around the roots where it is needed and evaporation retarded.

It is in the kitchen garden that infiltration attains marvelous results, particularly in the culture of root plants. In fact, it is the only system of irrigation which enables plants to obtain the greatest quantity of nutritive elements from a given surface. The soil is never at rest, and where the climate is favorable, one crop after another may be grown all the year around, and even in climates where the farmer is satisfied with one crop each season he may easily raise two. It is the equivalent to hothouse culture so far as growth is concerned, but the plants possess a quality unknown to forced cultivation.

WINTER IRRIGATION.

Infiltration or sub-irrigation is an admirable system for what is known as "winter irrigation," when the water supply is more abundant than is the case in the dry or growing season in humid climates. Water is run into the underground conduits to fill the soil with moisture, and then by the further storing up of the water in excess, surface irrigation becomes practicable when it comes to planting, and plants are supplied with moisture until their first true leaves are formed, by which time their roots are in moisture laden soil and they grow to maturity with very little after irrigation, unless shallow rooted, in which case surface irrigation is always necessary.

There are three atmospheric and meteorological conditions which should be considered under the name of winter: In the arid and semi-arid regions of the South and Southwest and on the Pacific slope, where the Kuro Siwa or Japanese ocean current creates a perpetual spring climate, what is known as the winter season is the growing period generally for cereals and garden products—it is the "wet season." If there be any rainfall at all it begins about November and ends in April. Sometimes the rainfall is not more than five or ten inches, perhaps fifteen inches, an amount so small to a farmer in the humid regions that he would not venture to move a plow, but eight inches is considered sufficient to raise a reasonable crop without irrigation, provided there is constant cultivation. In such regions every drop of water is utilized and care taken to prevent evaporation.

In such a climate the farmer dry plants, that is, he puts his seed into the ground when the latter is as dry as powder, plowing it up previously or plowing his seed under. There being no moisture of course it does not sprout, but lies in the soil as safely as in his barn bin. But when the first rain comes, perhaps only half an inch, his seed is up in a few days, and then begins cultivation to prevent evaporation. This is continued during the entire season, after every shower, large or small, so that his crop matures very well on eight inches of water from the clouds, aided, however, by dews and mists, which, as has been said in a former chapter, is quite considerable.

Here winter irrigation is of the most incalculable benefit for the deciduous plants which spring into life in March and April, small fruits, orchards and the like, for it fills the soil with moisture, and when a trifle of surface irrigation is added the plants continue growing with profusion and produce profitable crops.

In the totally arid regions where there is no rainfall at all, nothing but aggravation mists, or heavy, foggy dews, nothing can be grown without irrigation of some kind, and experience has demonstrated that surface irrigation can not very well be performed unless there is an ocean of water at hand to be wasted in evaporation, for the climate is usually hot. Now, if the soil can be moistened by infiltration through subterranean conduits, that moisture will remain in the soil for an indefinite period and may be added to by subsequent irrigations. The fact is, that this system of sub-irrigation furnishes an artificial water table which provides capillary attraction something upon which to operate.

The same results may be attained by running water into deep open furrows, care being taken to cultivate over immediately, and then infiltration or seepage will begin operating, and whatever excess there may be will find its way into the soil in all directions, from a higher field to a lower one, and from one slope to another, for instance.

The second climatic condition is where the region is cold and frosty, precluding winter growth, and without very much snow or other precipitated moisture. Here sub-irrigation prepares the soil for spring cultivation, and sufficient water is retained for surface irrigation when needed. It should be observed that constant and deep soil cultivation is as much necessary in such a region as in an arid or semi-arid one, the rule being that the roots of plants must be provided with adequate moisture regardless of surface conditions.

The third condition of climate is where the rains and snows of winter are comparatively heavy, equal to the rainfall in the sub-humid sections, but the cold is too great to permit any sort of plant life. In such case winter irrigation is as much of a necessity as in the arid and semi-arid regions because the necessities are the same. There is a cessation of water precipitation in the spring of the year, or else the precipitation during the growing season is not sufficient to mature a crop, hence there must be water enough stored up in the soil to meet the coming drought.

IRRIGATION BY SPRINKLING.

Water sprinkling is practically artificial rain in a small way. In an arid climate it is of trifling advantage unless other means of irrigating are employed, or unless there is a thick growth of vegetation which shades the ground, or "mats," as in the case of strawberries, etc. It is adapted to garden culture, however, and in horticultural cultivation generally it is of the highest excellence. Where water can be conveyed in pipes, with hydrants placed at intervals to admit of hose attachments, there is no better system of irrigation, though

in this, as in all others, the soil must be kept open to retard evaporation, otherwise constant applications of water are necessary to keep plants growing.

Where water is not obtainable from pipes and hydrants, a tank on a two wheeled cart, with a projecting sprinkler is commonly used. In ordinary vegetable gardens hand sprinklers are used, the water being run into a convenient reservoir, which may be a barrel sunk into the ground, and the water dipped out. With one or with one sprinkler in each hand. the irrigator walks along the rows, slowly sprinkling the plants with water until it runs off the ground as in a rainfall. Many plants are benefited by this system of irrigation. Flowers, small bush fruits, strawberries, and even trees, the spraying of water upon which washes the leaves and freshens them, or as it is sometimes expressed, "gives them a drink."

In market gardens in proximity to cities, hydrant water is plentiful and this is used for sprinkling or any desired system of irrigation. Lawns are watered by means of a rubber hose with all sorts of attachments intended to scatter the water over the largest space. Where windmills are in use and elevated tanks common, all the advantages of hydrant water may be secured at small expense, and the same is the case where the farmer is so fortunate as to have an elevated acre or two of ground in which to dig a catch reservoir. There are some doubts as to the proper time during the day to irrigate crops or plants by sprinkling. Some contend that the evening or the early morning is the best time while others, again, contend that it does not make any difference. It does make a difference, when one stops to think. In the early morning the water is chilled after the hours of the night, and when water is applied after sundown it becomes cold and where the water is colder than the plant it is not beneficial, but stops growth. To recur again to the everlasting Chinaman, whose ideas are founded on centuries of success in growing anything he attempts, he can be seen religiously pouring water on his plants, even the most delicate, while the hot sun is shining down upon them with a burning heat. One looks in vain for the plants to droop and wither under such treatment, for they keep on growing vigorously and luxuriantly under the influence of the heat and the watery vapor engendered by the heat of the sun.

There can be no doubt that by the constant or regular application of water to the soil, in quantities to equal evaporation, the ground will be maintained in a moist condition favorable to plant growth. Moreover, there is always less water required for a second application than for a first one, and the quantity diminishes with each application, until a modicum of water will be reached and a profitable crop raised economically. Where there is no water in the subsoil, or at least none attainable by capillary motion, irrigation creates an artificial one which may be drawn upon by aeration of the soil by deep cultivation. Where there is a water table already within serviceable distance of the surface, irrigation may be so regulated as to keep the soil open and aerated by the flowing of water through it, and when that object has been attained, the labor of irrigation will have been reduced to an economical minimum and production astonishingly increased.

We shall have more to say on the subject of subirrigation in a special chapter devoted to the system.

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,
Expert in Drainage and Irrigation, U. S. Department of Agriculture.

From Farmers' Bulletin No. 187, Courtesy U. S. Department of Agriculture.

(CONTINUED.)

The capacity of drains for carrying water may be computed quite accurately, but the modifying conditions and the quantity of water it is desired to remove in a given time are just as important elements in any determination of the problems. Any table which can be computed will apply only to the conditions assumed, whereas each drain presents a problem which should

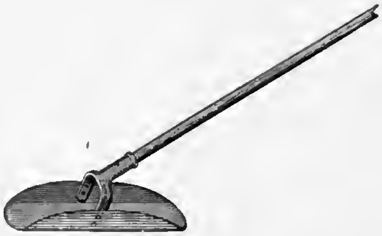
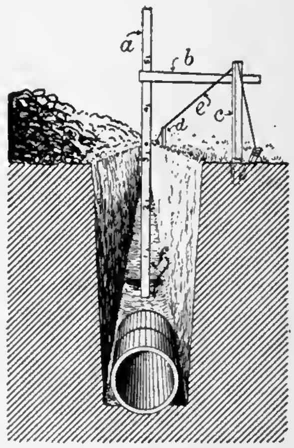


Fig. 11.
Grading Scoop.

be solved with all its peculiarities considered. The following table has been computed to serve as a guide in adjusting the size of mains to the area which is to be drained. Two cases only are considered—one in which the mains are 1,000 feet long, and the other in which they are 2,000 feet long. Lateral drains should be three inches and four inches in diameter. Submains or large

Fig. 12.
Grading by Line and Gauge.



branches which themselves receive the drainage of laterals should be regarded as mains in considering their size. The table is computed for removing one-fourth inch of water in depth each twenty-four hours from the area drained. Should the conditions be such as to require the removal of a greater depth of water in twenty-four hours, a proportional reduction in the num-

Fig. 13.
Tile Hook.

ber of acres given in the table may be used; that is, if it is desired to remove one-half inch of water instead of one-fourth inch, the sizes given in the table will

serve one-half the number of acres. If it is desired to remove only one-eighth inch the sizes given in the table will serve twice the number of acres indicated.
in this chapter because it is important to keep constantly in mind the principles advocated in this book. The author is not following any beaten track nor relying upon theory, but has taken experience as his guide, and made assertions that can be easily verified in actual experience.

In the use of the table for determining the size of drains, good judgment must be exercised in applying it to the case in hand. The tract under consideration may have such surface slopes that the underdrains may be called upon to take the drainage of a much larger area than if the land were nearly level. By reason of the surface slope and drainage a main may be required to receive the drainage of twenty acres instead of ten, as would appear at a casual glance. It is important to take into account also all the facilities for natural drainage when one undertakes to drain land by tiles. Too large tiles involve an expense without adequate return, while those which are too small may entail an annual loss that will soon equal the amount that was apparently saved in their purchase.

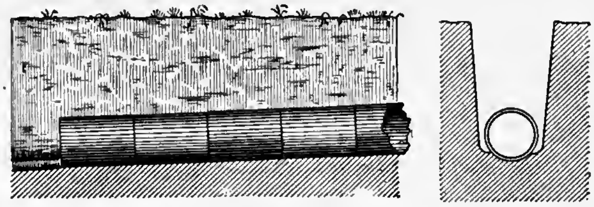


Figure 14. Large Tile Main in Place.

The present tendency in drainage is to use large tile mains in place of small open ditches where land is worth $200 an acre or more. It is not uncommon to use tiles eighteen and twenty inches in diameter. Where large tracts are drained some surface relief drains should also be provided against excessive rainfall in order to keep the expense of the main underdrains within the limits of paying returns.

AREAS FROM WHICH ONE FOURTH INCH OF WATER WILL BE REMOVED IN TWENTY-FOUR HOURS BY OUTLET TILE DRAINS OF DIFFERENT DIAMETERS AND DIFFERENT LENGTHS WITH DIFFERENT GRADES.[a]

Diameter of tile in inches.	Grade per 100 feet in Decimals of a foot (with a approximate equivalents in inches).											
	0.04 (½ in.).		0.05 (⅝ in.).		0.08 (1 in.)		0.10 (1 3-16 in.).		0.12 (1½ in.).		0.16 (2 in.).	
	Length of drain in feet.											
	1 000.	2.000.	1,000.	2,000.	1,000.	2,000.	1,000.	2,000.	1,000.	2,000.	1,000.	2,000.
	Acres of land drained.											
5	17.3	13 5	17.7	14.0	19 1	15.7	19.8	16.7	20.6	17 6	22.1	19.4
6	27 3	21.4	28.0	22 2	29.9	24.8	31.2	26.4	32.5	27.8	34.8	30.5
7	39.9	31.4	41.1	32.7	44.1	36 4	45.9	38.7	47.7	40.8	51.1	44.8
8	55.7	43.7	57.3	45.6	61 4	50 7	64.0	53.9	66 5	57.0	71.2	62.6
9	74.7	58.8	76.5	61.2	82.2	68.1	85.6	72.3	89.1	76.3	95.3	83.8
10	96.9	76.3	99.5	79.5	106.7	88.5	111.2	94.0	115.6	99.2	123.9	108.9
12	152 2	119.9	156.1	124.9	167.7	139.3	174.8	147.9	181.7	156.2	194.6	171.6
14	222 8	175.9	228.7	183.7	245.3	204.3	256.1	217.4	265.8	229.7	284.9	251.7
16	310 2	245.0	317.8	255.9	341 4	284.6	355.4	302 5	369.5	319 7	396.3	350.4
18	414.4	328.7	424.9	342.5	456.4	381.3	475 7	405.5	494.4	428.1	529.1	470.1
20	537.6	426.9	551.6	444.9	591.5	495.8	616.4	526.7	640.4	556.6	686.3	610.5

Diameter of tile in inches.	Grade per 100 feet in decimals of a foot (with approximate equivalents in inches).											
	0 20 (2⅜ in.).		0.25 (3 in.).		0.30 (3⅝ in.).		0.40 (4⅝ in.).		0.50 (6 in.).		0.75 (9 in.).	
	Length of drain in feet.											
	1,000.	2,000.	1,000.	2,000.	1,000.	2.000.	1,000.	2.000.	1,000.	2,000.	1,000.	2,000.
	Acres of land drained.											
5	23.5	20 9	25.1	22.7	26.7	24.5	29.5	27.5	32.0	30.3	37.7	36.3
6	37.0	33.0	39.6	35.9	42.0	38.6	46.4	43.5	50.5	47.8	59.4	57.3
7	54.3	48.5	58 0	52.8	61.6	56.7	68.2	63.8	74.0	70.1	87.1	84 1
8	75.6	67.7	80.9	73.6	85.8	79.0	95.0	89.1	103.3	98.0	121.4	117.3
9	101.4	90.7	108.4	98.6	114.9	106.0	127.0	119.4	138.1	131.3	162.6	157.1
10	131.6	117.9	140.6	128.1	149.3	137 6	165.2	155.3	179.2	170.5	211.1	204.4
12	206 8	185.6	221.1	201 8	234.5	216.9	259.2	244.1	281.8	268 6	331.8	321.7
14	302.5	272.2	323.5	296.1	343.5	318.1	379.7	358.2	412.9	393.9	485.8	472.1
16	420.6	379.1	449.9	412.2	477.4	442.9	527.8	498 4	573.7	548.8	675.2	657.3
18	562.2	508.1	601.8	552.5	638.1	593.7	705 2	668.0	767.4	735.1	902.3	880.5
20	729.2	660 3	780.0	718.2	826.9	771.1	914.7	867.8	994.5	954 6	1,170.1	1,144.1

[a] This table was computed from the formulas for determining the size for tile drains given in Elliott's Engineering for Land Drainage, which are:

$$(1)\ v=48\sqrt{\frac{d(f+\frac{1}{2}k)}{l+54d}}$$

$$(2)\ Q=av$$

$$(3)\ A=\frac{Q}{.0105}$$

Where v=velocity of flow in feet per second.
a=sectional area of tile in square feet.
d=diameter of tile in feet.
f=total fall in length of drain.
k=depth of drain in feet at upper end.
l=total length of drain in feet.
Q=discharge of drain in cubic feet per second.
A= acres drained.
Constant 0.0105=quantity of water to be removed from 1 acre in 1 second of time.

Computations are made for two assumed lengths of drain—1,000 feet and 2,000 feet. $\frac{1}{2}k$ is 1.5 feet, that is one-half of depth of drain where the soil is open and saturated with water, under which conditions the drain will discharge its maximum quantity. Where the soil is close no additional head will be added by the free water of the soil, so that the factor $\frac{1}{2}k$ should be omitted in computations. Three feet of soil above the top of the drain has been assumed. It will be be readily seen that the grade, length of drain, and openness of soil are important factors in the capacity of a tile drain for discharging soil water.

DIGGING THE TRENCH.

The trench should be started on the surface by a

line and should be made clean-cut and straight. Any curve made at the surface will ordinarily be greater when the bottom is reached. If a survey has been made, a line should be drawn about five inches to one side of and parallel with the line of grade stakes. It is assumed that these stakes have been set on a true line fifty or one hundred feet apart and that the depth of the cuts from the top of each grade stake to the grade line of the ditch has been furnished to the workman or marked upon the guide stakes which denote the position of the grade stakes.

The digging tools which are necessary in easily worked soils are as follows: A ditching spade with blade eighteen or twenty inches long, a round-pointed shovel with long handle, and a grading scoop of the "pull" pattern (Fig. 11). In light, mucky soils a muck spade, which is a three-tined fork with a steel cutting edge like a spade, can be used with profit. Where the clay is hard or stony a pick and iron bar will be necessary. Straight ditches and neat work should be insisted upon, since the labor required is no greater than in digging crooked and ragged ones, and a drain in a neat line is more efficient than one which has short irregular crooks. Where it is necessary to change the direction of the line it should be done by an easy curve. When a lateral drain joins another it should form an angle of about 30° with it.

(*To be Continued.*)

CHANCE FOR INVESTMENT.

In this issue will be found an advertisement of the Northwestern Consolidated Oil Company, whose main field of operations at present is at Belton, Mo. This company has been organized for two years and owns and operates a territory covering a total of 1.300 acres in three oil fields. At Belton, Mo., twenty-four miles from Kansas City, this company has one excellent well producing a high grade of lubricating oil. The pumping plant, tanks, all necessary buildings and good machinery are all paid for.

This oil can be developed into various by-products and the company contemplates the erection of a refinery to handle the oil and place it on the market. Owing to the fact that so many illuminating oil propositions are before the public at the present time, it is well to consider the circumstance that this oil is a high grade lubricant, which commands a much larger price and consequently a much larger profit than may be obtained from illuminating oils. In a conversation recently with Mr. Nelson J. Russell, who is the head of the company, he informed us that he has invested something like $21,000 of his own money in this plant and is exceedingly hopeful of its future. He stated that $10,000 additional capital is now needed for the further development of the property and is satisfied that after the expenditure of this money the company can pay dividends of at least 8 per cent on capital stock as soon as the plant is in good working order. At the present selling price of the stock, the par value being $1.00. and the selling price fifty cents, the earning capacity of the stock would be 16 per cent, and this income is guaranteed on the fifty-cent stock by the issuance of bonds to each purchaser to cover his investment. These bonds are underwritten by a well-known security company and the security back of the bonds is composed of railway and high grade municipal bonds. The stock issued and sold without this guarantee (and remember. only a limited amount of the stock will be sold) which is not protected or secured by the bond company, is put on the market at twenty-five cents per share, while that which is backed by the security bond is sold for fifty cents per share, the purchase of either being optional with the individual interested, as the stock is the same and the twenty-five cent stock will earn equally as much

FLOW OF OIL FROM BELTON WELL.

as that secured by the bond after the property is fully developed.

One strong feature about this investment is that the wells are located within hauling distance by wagons of Kansas City, thereby precluding the possibilities of freight or railway interference, as sometimes occurs with other corporations out of the control of the heavier corporations. The company only desires to raise $10,-000 to complete the work already well started and when this sum is raised no more stock will be offered, as those in control are fully satisfied that that amount will place the business on a good paying basis. Up to the present time the Northwestern Consolidated Oil Company has been a close corporation. All the money expended so far has been by the organizers, which in itself shows their good faith and that it was not organized as a stock selling proposition. If our readers will look into this we are satisfied that they will find the investment fully warrants their consideration.

In connection herewith is a half-tone photo showing flow of oil from the well now in operation. Please bear in mind this is a lubricating oil. The photograph shown in the advertisement, which appears on another page, is of the well at Belton at the time it was shot.

TO IRRIGATE CROW RESERVATION.

Custer Battlefield Within the Limits—Over One Million Acres to Be Reclaimed.

NORTH YAKIMA, Jan. 2.—The Crow Indian reservation is one of the historic spots of the great Northwest. It has been brought to notice recently by the fact that efforts are being made to have a large area opened to settlers. A big tract, comprising 1,100,000 acres, will be set aside and given to home builders. The Indians have no use for the lands. They occupy all that their limited abilities can control. In the years past these lands have been leased to cattlemen for about two cents an acre per year. That condition is about to change and farms will be carved from the richest agricultural area in the Northwest.

The Crows number about 1,800 men, women and children. They live upon their allotments and hold the lands in severalty. No Indian can transfer his right to lands, but the tribe may consent to the sale of that which is not considered advisable to retain. A treaty has been made with the tribe and the large area formerly leased for cattle grazing will be sold to the Government. This will then be thrown open for settlement under the homestead laws of the United States. The citizens of the Yellowstone Valley are elated over the prospect of having new neighbors.

This reservation contains the historic Custer battlefield, where Gen. George A. Custer and his command, comprising a portion of the Seventh cavalry, fell on June 25, 1876. The large battlefield has since been fenced and dedicated as a soldier's cemetery. Over 1,000 graves, marked by white monuments, show the resting places. Around the cemetery are fields of alfalfa, wheat and potatoes, cultivated by the redmen and their sons. A wonderful change has come over the country. The cause for this is irrigation.

Many irrigation canals have been constructed by the Indians and their white friends. The Montana farmers are wealthy. Their lands are productive and their flocks and herds yield good returns. The State Commissioner of Agriculture reports that there are 13,370 farms in the State, producing an average income of 20 per cent annually on the investment.

The Yellowstone Valley has 383 of these farmers. But they are not content to live alone. They want others, from every land under the sun, to join them and convert the once howling wilderness into a land of orchards, gardens and vineyards.

An irrigation canal is being constructed on the north side of the Yellowstone River, overlooking the Indian reservation. This great water carrier is to extend for fifty miles. It will be forty feet wide on top and carry a volume of 500 cubic feet per second, making an artificial river five feet deep and forty feet wide. A tract comprising 25,000 acres, owned by the Billings Land & Irrigation Company, will be reclaimed and put under cultivation next year. The canal will become the property of the people, after all rights are sold and handled on the co-operative plan.

Twenty-five years ago this country was almost unknown except to the painted warriors and soldiers. Now it is crossed by the Chicago, Burlington & Quincy and the Northern Pacific railroads. Tourists may look out from the windows of the Burlington and gaze on the famous field of the Custer battle. The only evidences of former barbarism are occasional glimpses of Indian veterans wrapped in their blankets, or blackened tepees from which emit the curling smoke sending up its messages of peace from the squaws and papooses who are happy because their tribe is no longer at war.

JOEL SHOMAKER.

William Henry Jaques, a gentleman prominent in irrigation affairs, is shown in accompanying halftone. His home is at Little Boar's Head, N. H.

We show herewith miniature halftone of Hon. John Hall, vice-president of the Twelfth National Irrigation Congress. He formerly lived at Syracuse, Kan., but is now making his home at Lampasas, Tex. Mr. Hall has always taken an active interest in irrigation affairs and will no doubt appear prominently in the deliberations of the national congress to be held at El Paso in November of this year.

THE LEFFEL NEW CATALOGUE.

The new catalogue of engines and boilers made by James Leffel & Co., of Springfield, Ohio, is a book that will interest many of our readers. It should interest anyone who has to do with steam power. This book goes into the matter of the making of Leffel engines and boilers, and shows on what their superiority is based. The book is well gotten up, printed on heavy enameled paper, has numerous full-page and many smaller illustrations, and is filled with just such detailed information about engines and boilers as to make it truly valuable to those using or contemplating using an engine or boiler. The book will be mailed free to prospective buyers of an engine or boiler, stating wants and addressing the company as above.

42 PRINTERS' INK

EDWIN F. ABELL, head of the company that publishes the Baltimore *Sun*, died in that city February 28, aged sixty-three years. His father, A. S. Abell, was the founder of the *Sun*, which dates from 1837, and the deceased was the last surviving son, having had the management of the paper for ten years past. His death was, in a measure, brought on by grief and shock following the Baltimore fire.

THE *Irrigation Age*, published monthly in Chicago by the D. H. Anderson Publishing Co., has absorbed *Modern Irrigation*, Denver. There are five publications in the United States devoted to the subject of irrigation, and the *Irrigation Age* leads them in point of circulation, being credited with a monthly average of 22,100 copies for 1903 in the Roll of Honor. The consolidation gives a further increase. The Denver publication made no statement of circulation, and was credited with H—exceeding 2,250 copies. The *Irrigation Age* is nineteen years old, and is said to have readers in all parts of the world among individual irrigators and irrigation corporations.

THE Hackstaff A
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THE cir edition of increased t past year, i no change advertising

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Vol. XIX. No. 9.

THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

JULY, 1904.

THE D. H. ANDERSON PUBLISHING CO., Publishers.
112 DEARBORN ST., CHICAGO.

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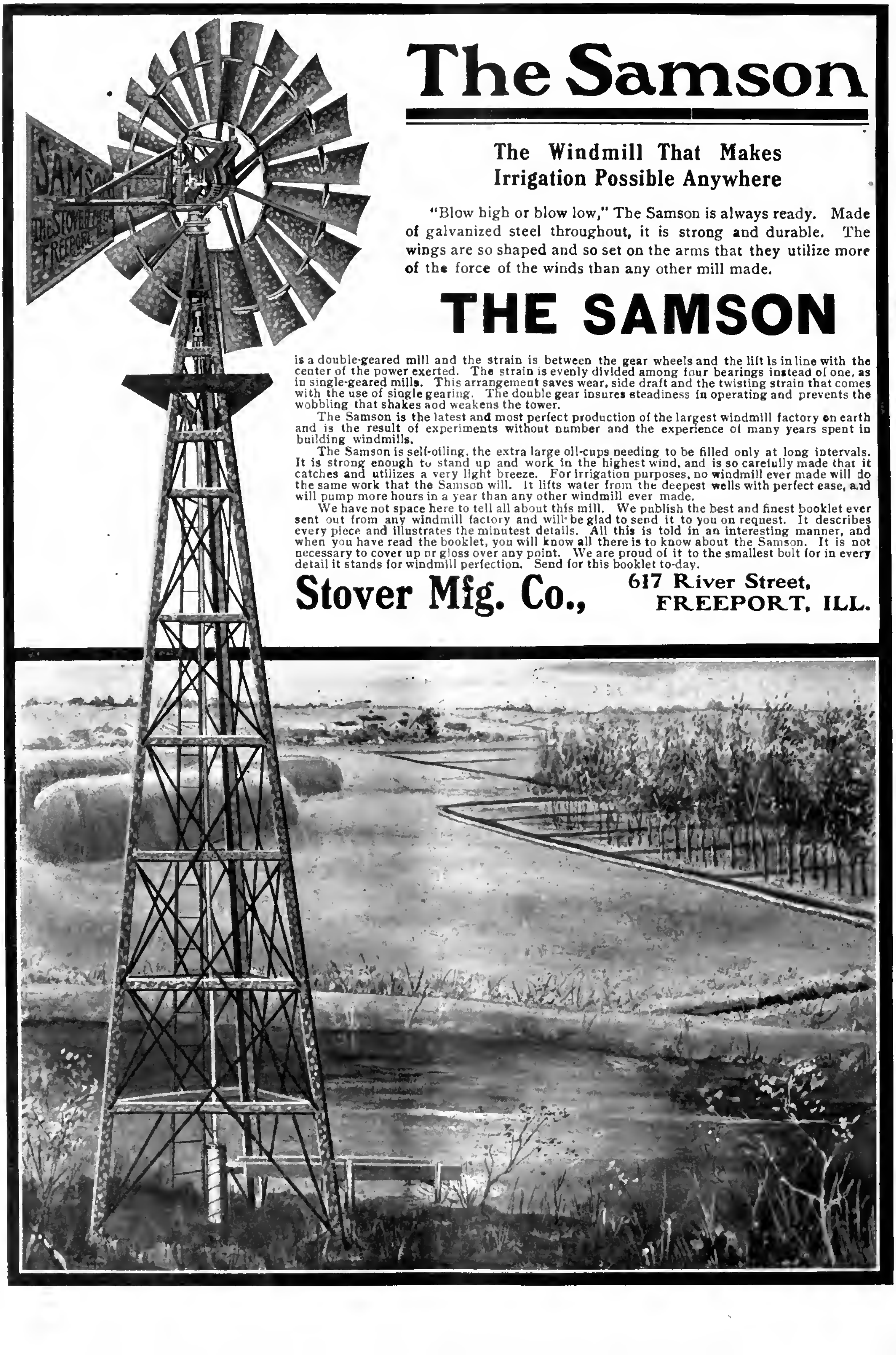
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THE IRRIGATION AGE

VOL. XIX CHICAGO, JULY, 1904. NO. 9

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION — THE DRAINAGE JOURNAL
THE IRRIGATION ERA — MID-WEST
ARID AMERICA — THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the Industrial growth of the West.

EDITORIAL

The Irrigation Age has been informed that an investigation has been started by several gentlemen, who are prominently placarded as officials of the National Irrigation Association, which will, no doubt, result in the resignation from that organization of a large number of manufacturers whose names have been prominently used by its officials. If the proper steps are taken and the investigation is thorough there is no question but that all the men interested will withdraw from membership.

Utah Irrigation. We are presenting in this issue the first of a series of articles by Prof. John A. Widtsoe, director of the Utah Experiment Station, on the irrigation investigations at that station. This article will be found highly interesting and will be followed by others, which will prove of great value to all our readers. Beginning with our issue of August, we will publish in serial form Bulletin No. 86, issued by the Agricultural College of Utah on "The Right Way to Irrigate." This article will be profusely illustrated with cuts made from photographs taken in the fields of the experiment station. The photographs used for these illustrations are considered the best irrigation pictures yet brought out and will materially beautify and strengthen this series of articles.

George B. Cortelyou. We note a great many comments recently in the daily papers concerning the fitness of Mr. George B. Cortelyou as head of the National Committee and are pleased that the majority of the papers look kindly upon this gentleman. One remarkable thing about the comments made on the advance of Mr. Cortelyou from the position of court reporter in New York to a cabinet position within a comparatively few years, is that they fail to attribute any direct cause as a ground work for his advancement.

While the writer has never had the pleasure of meeting Mr. Cortelyou personally, he has at various times had correspondence with him while he was filling the position of secretary to President McKinley, and later to President Roosevelt, and from the extremely courteous manner in which the gentleman treated all subjects brought to his attention, it is easy to understand why he has such a hold on the people with whom he is brought in closest contact. One writer, Mr. Walter Wellman, stated that his success is due to the fact that he has made an effort to do all things well and has paid close attention to the smaller affairs of life, and this is no doubt true. But it is our impression that his great strength lies in the fact that he is uniformly courteous with all with whom he is brought in contact, either personally or by correspondence, and THE IRRIGATION AGE is glad to testify so far as it may to its appreciation of Mr. Cortelyou, and fully believes that there is nothing good which the future may have in store for him that he does not deserve.

An Eruption Not Unlikely.

The evidence is accumulating that certain persons who are endeavoring to divert the irrigation law of Congress from its beneficial purpose to provide homes for American citizens. actual homeseekers, into a means of private speculation, will soon be brought up with a round turn by a power that will show them little mercy when the facts are laid before it.

We know that scant ceremony has been shown those engaged in various larger and smaller swindles in the Postoffice Department, though that concerned only the Government directly and the people indirectly, and we feel assured that when it comes to scheming against the people directly to take from them what is for their benefit, for the public welfare, the hand will be laid upon them without distinction as to dignity, ill gotten wealth, or political influence.

Does any one suppose that a man like President Roosevelt, whose heart and soul are wrapped up in the welfare of the people of this country, is racing through the land blindfolded? Or that he is not taking notes of conditions wherever he goes to verify the manifold complaints that have been laid before him? This man we have for President is not a political ward striker, who closes his eyes to the deeds of those he has in his employ, or wink at the tricks of his henchman. He is a man who has openly declared that he is the President of the people of the United States, and not the leader of any clique, gang or combination of appointees, who can set at naught the spirit of our laws and expect to escape punishment.

The Romans had a saying to the effect that "whom the gods would destroy they first make mad," the plain meaning of which is that men pursuing a crooked path are so mad as to imagine they can continue in it with impunity and involve themselves in such a labyrinth of wickedness that all trace of them will be concealed from the eye of the avenger. They are mad to dream that their iniquities may not be laid bare, their willful tampering with law, justice and right undetected.

The plain meaning and intent of this writing is that there are those who are at present ruling the subordinate powers of the Government for their private gain; that a combination exists to select for themselves the choicest locations under the irrigation law and leave the remnants, the "culls," for the people, who believed the President to be speaking in good faith when he said that law was for the benefit of actual, bona fide homeseekers and not for a gang of speculators, composed of Government officials led by private adventurers, whose whole occupation consists in working against the intent of the President, the intent of Congress, and making both belie their words.

Such is the opinion of the people who are not blind to the corrupt influences creeping into the management of the machinery conducting the operations under that irrigation law, and such soon will be the opinion of the power, who can crush out the pernicious influence when the accumulated evidence shall have been laid before it.

We go so far as to say that even if President Roosevelt should endanger his chances for election, he would not hesitate to oust summarily these derelict officials who openly boast that their influence is sufficient to mar his chances if he dare interfere with them.

This is not a note of warning to any one implicated. It is notice to a long suffering and defrauded people that the Aegean stable in and behind the Geological Survey will as surely be cleaned and fumigated as that you read this prophecy in THE IRRIGATION AGE.

The Pump as a Farm Factor.

The far western farmer, necessarily resourceful from the very nature of his surroundings, is rapidly developing the great bodies of water whose outlets can not be utilized for surface irrigation. The modern pump is rapidly becoming an important factor in developing large sections of the arid West. It has long been known that large sheets of underground water exist in many sections where the surface presents nothing but apparently hopeless problems to the agriculturist. It is only within the last few years that the ingenuity of mechnical engineers has solved an easy and inexpensive way of raising this water to the surface and distributing it over the thirsty land to make it bloom and blossom as the rose.

In some of these parched deserts wells sunk to the depth of two or three hundred feet bring great gushing streams to the surface whose flow is as constant and regular as the rivers and streams of the mountains themselves. In many places, however, the water lies too near the surface to give a self-raising force and where this condition exists the modern pump is brought into use. Shafts are sunk to the water body; the pump is put into operation and the stream rises to the surface and instantly reclaims land that has been fit for nothing but sage brush and the home of the jack rabbit for centuries.

The Division of Engineering and Drainage of the Department of Agriculture is doing great work in educating the people of the West how to take advantage of these underground bodies of water and utilize them for their benefit. Careful surveys are made showing the exact locations and boundaries of these underground lakes and streams, and the seeker after water may sink his well or his shaft with the certainty of finding water without the tedious and expensive process of haphazard experiment. In the Pecos Valley in New Mexico along the line of the Sante Fe railway, in Utah, along the line of the Union Pacific, and in certain sections of North and South Dakota, traversed by the Northern Pacific and Great Northern railways, in Southern Cali-

fornia, through which runs the Southern Pacific, large areas of unproductive land are rapidly being brought to a state of high cultivation and usefulness through the pumping system.

This work is in its infancy, and there is no doubt that its development during the next fifteen years will be far beyond the imagination of the average man who has not thoroughly investigated the possibilities and wonderful resources of these underground waters. Most of this work is now being done by private parties because the expense is insignificant as compared with other methods of irrigation. A half dozen farmers can join their resources in the purchase of pumping machinery sufficient to irrigate small farms and insure them a constant and unfailing supply of water at a comparatively small cost. The work can be done quickly. A promising section having been selected, pumping machinery can be installed and the water brought to the surface in the course of a few weeks, whereas the construction of surface irrigation ditches requires months and years. This system of irrigation as an adjunct to the great surface work that has been planned, and is now being put into operation by the Government and large private land companies, will reclaim almost every portion of the arid West and add immeasurably to our vast agricultural domain.

ON SHOSHONE PROJECT.

State Engineer Johnston Will Talk on Great Government Enterprise.

State Engineer Clarence Johnston has a number of very fine photographs of the Shoshone canon and vicinity, which he took on the occasion of his examination of the Government dam site some weeks ago when accompanied by the consulting engineers. The site selected by the Government for its first reservoir in the State is very picturesque.

Below the junction of the forks of the Shoshone the river passes through a deep gorge which is cut through a mountain. The walls of this canon rise to a height of about 3.000 feet above the river, making it one of the deepest and wildest canons in the State.

One of the views is taken from a granite promontory 1,400 feet above the river. From this height the river looks like a small stream and yet the walls of the canon rise high above the point from which the picture was taken.

Other views show the mouth of the canon, the neighboring mountain, the bench along which the great canal will run, the town of Cody and neighborhood as well as a number of views of the river.

Professor Johnston is having some colored lantern slides made of these pictures and will deliver a lecture on the Shoshone project illustrated by these views before the Young Men's Literary Club.

It is hoped that the club will call an open meeting for the occasion, as there are many who would be interested in hearing of the Shoshone project and seeing pictures of the great canon, which will be the location of the great dam for which the Government has appropriated over $2,000,000.—*Wyoming Tribune.*

THE IRRIGATION INVESTIGATIONS OF THE UTAH EXPERIMENT STATION.

DR. JOHN A. WIDTSOE,
Director, Utah Experiment Station.

THE ANTIQUITY OF IRRIGATION.

History teaches that the great nations of antiquity lived in irrigated countries. In the great valley of the Mesopotamia, where written history begins, were located the wonderful cities of Babylon and Nineveh, surrounded by the most perfect canals and other irrigation devices yet known to man. Egypt, also, which looms large in the history of the world, has always depended upon irrigation for its wealth and prosperity. On the American continent, especially in Mexico and Peru, the numerous remains of skillfully constructed canals show that the most prosperous among the early inhabitants of this continent were those that resided in the irrigated districts. The coincidence of a high civilization with the practice of irrigation is not, in any sense, accidental. Countries in which irrigation is necessary usually possess relatively dry and warm climates, under the influence of which extremely fertile soils are produced, which with the control over the growth and quality and yield of crops that irrigation affords, makes possible a more satisfactory system of agriculture than can be developed in countries of abundant rainfall. In the days of the ancients, the art of irrigation was undoubtedly developed to a degree commensurate with the best knowledge of those times, and, undoubtedly also, the principles concerning the actual tillage of the soil were not better understood in those days than were those relating to the application of water to soils for the production of plants.

THE CONDITION OF FARMING A CENTURY AGO.

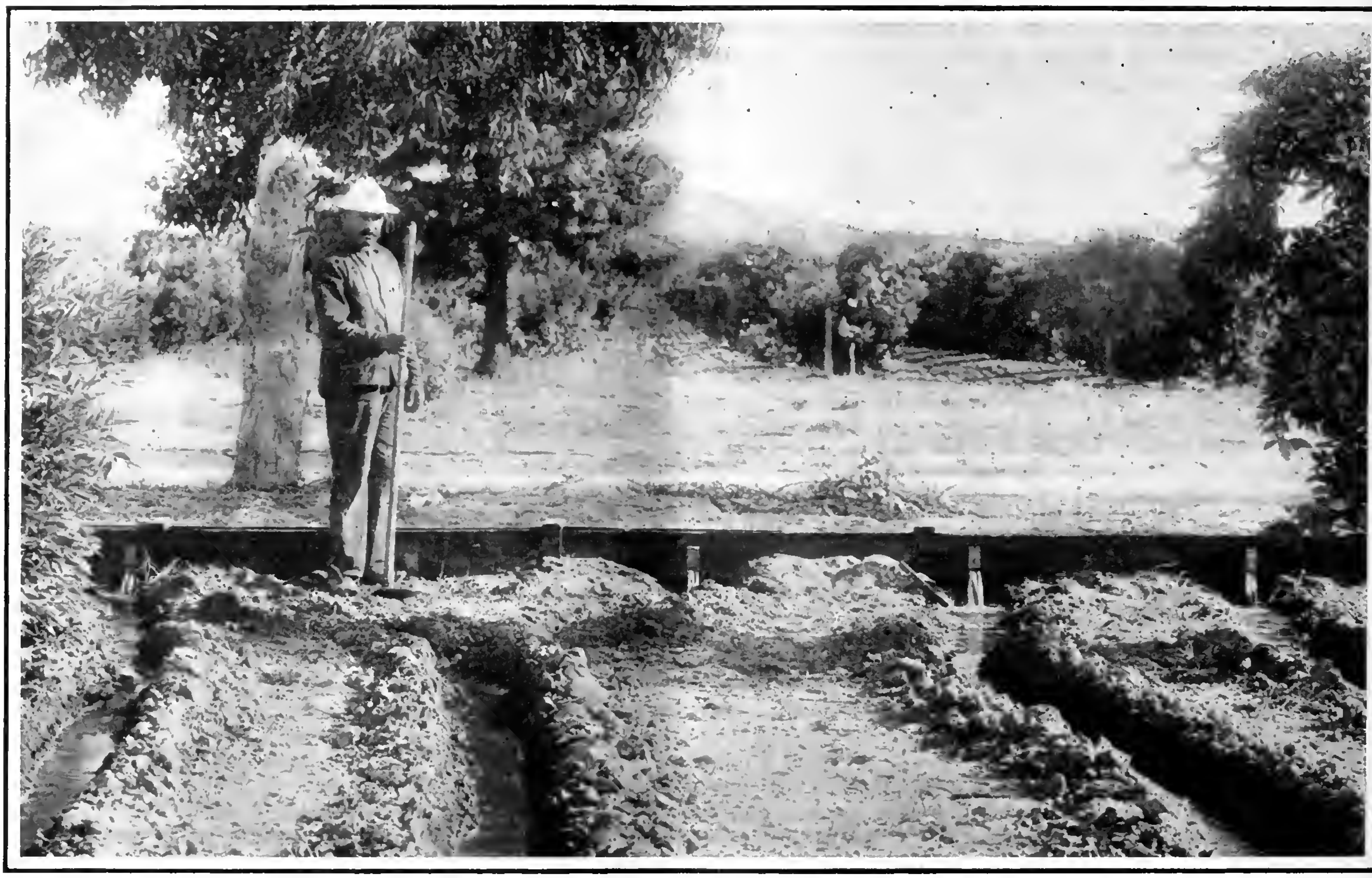
The learning of the ancients has been, in a large degree, lost to us, and we know little more concerning the methods of agriculture and irrigation of antiquity than is indicated by the ruins of their magnificient irrigation works.

With the loss of the earliest civilization, the art of agriculture was reduced to a practice based upon empirical rules, some of which were good, many of which were bad, and all of which had been formulated without special reference to the laws of nature. In fact, during very many centuries of the earth's history the condition of the art of agriculture has been such that it has attracted only those who were incapable or unable to follow the more developed and progressive professions. Nevertheless, the thinkers of all ages have clearly understood that the prosperity and happiness of a nation root in the agriculture of the country, and that no country can be truly and permanently great which does not practice an intelligent system of soil cultivation, in which some of its best minds are enlisted. Many attempts were made in early days to apply the little that was known of the operations of nature to the betterment of agriculture, but the elementary condition of science itself made such attempts void of results of any consequence. One hundred years ago, the practices of agriculture were in this lamentable condition, resting only upon the vague traditions of the past, and inviting into the service only the most inferior classes of men in the community. The great land owner alone could be a farmer, and at the same time command intellectual and social enjoyment.

THE DEVELOPMENT OF MODERN FARMING.

It was about one hundred years ago, also, that the great branches of science which have done so much to transform the conditions surrounding civilized man during the last few decades, began to be developed. As soon as new principles were discovered, men of the highest training and intelligence immediately set to work to apply these discoveries to the profitable production of plants, and in consequence the growth of modern agriculture has been almost simultaneous and parallel with the growth of modern science itself.

The practices of modern agriculture rest upon the fundamental laws of physics, chemistry, biology and geology, and are modified and improved as new discoveries in science are made.



Courtesy Sunset Magazine. METHOD OF RUNNING WATER INTO ORCHARD FOR IRRIGATING PURPOSES.

So perfect is the system of the agriculture of today that it is worthy to be classed with the great applied sciences.

THE NEGLECT OF IRRIGATION.

The advancement of modern science has been due to the efforts of the great nations of Europe and America. That is, the men who have discovered the laws of nature and who have applied them to the art of agriculture have lived in countries of abundant rainfall where there was no need and little appreciation of the art of irrigation. As a result of this fact, the scientific study of the art of irrigation was neglected and it fell woefully behind that agriculture which is independent of the artificial application of water. In fact, it is only within the last few years that the attention of the great nations has been directed toward those portions of their domains which are arid in their nature and require irrigation as the basis of successful agriculture. In our own great country it is only within the last ten years that the great public has taken seriously the development of the great West, the larger portion of which can be profitably reclaimed only by irrigation.

The present condition of irrigation is, therefore, practically this: All branches of agriculture that are independent of irrigation have been developed to a very high degree and are steadily growing, while the branches that are definitely related to irrigation are just beginning their growth, and are practically in the position that general agriculture was one hundred years ago.

THE PROBLEMS OF IRRIGATION.

To many who have given this subject little thought, it seems strange that anything needs to be discovered about irrigation. They say, "If we have good soil and the water in the right position and the right kind of seed, all that needs to be done is to let the water flow over the ground and nature does the rest." In view of the neglect which the art of irrigation has suffered at the hands of scientific investigators, such a reply is only to be expected, yet it is an emphatic fact that the problems that irrigation offers for solution are very numerous and most intricate in their nature.

Irrigation problems may be grouped into three great classes:

First. The great problems pertaining to the storing of the mountain waters in large reservoirs, to be led to the farms during the growing season when the plants most require moisture. These problems are almost wholly of an engineering nature, though some of them concern themselves directly with the questions regarding the maintenance of the forest and range growth upon the mountains.

Second. Following the building of reservoirs, is the construction of the canals through which water may be carried to the farms. Here again numerous problems are involved, but these are also almost exclusively of an engineering nature.

Third. The farmer who receives water from the canal to be applied upon his farm also finds himself confronted by numerous problems of the most vital nature, so far as the profitableness of his operations is concerned. These problems are, in complexity and difficulty of solution, no whit behind those of the first two classes.

The problems of the first two divisions are much better understood than those of the third. This is due largely to the fact that dams, reservoirs and canals have been built in all countries and in all ages for purposes other than those involved in the art of irrigation.

SOME SOIL PROBLEMS OF IRRIGATION.

It is to the problems that confront the farmer in the actual application of water on the farm that the investigations undertaken by the Utah Experiment Station in 1900 have concerned themselves. In the experiments it has been clearly kept in mind that, in an arid region, the land itself has little value unless accompanied by a water right; and, moreover, that the amount of available water, even when all possible reservoirs shall have been built, will be sufficient to cover only a small fraction of the arable land. Water has been studied, therefore, in its relations to both soils and crops.

The water applied to different soils—sandy, loamy, clayey and calcareous—has been followed in its downward movement and it has been shown that by proper precautions drainage may be avoided and the danger of forming alkali in the lowering lands diminished or altogether eliminated. The lateral movement of water has likewise been investigated to determine to what extent the water applied to a field disappears by the lateral flow of soil moisture. The upward movement of soil water, after an irrigation, has been traced, with reference to the nature of soils found in the arid regions, the total moisture in the soil and the kind of crop growing on the soil. It has been found that the rate of loss of water from bare soils depends upon the nature of the soil, the depth of the soil, the hardpan or gravel bottom, the per cent of moisture in the soil, the meteorological factors, including temperature, sunshine and showers, the time after irrigation, the condition of the top soil, and the method of irrigation. The rate of loss from soils on which crops are growing has been found to depend upon the same factors, and in addition, upon the kind of crop grown and the age of the crop. In studying all of these conditions it has been found that there is a method of treatment which is better than all others in the conservation of soil moisture.

The relations of soil fertility to irrigation has also been studied with reference to the composition of the irrigation water, the nature of the soil, the addition of various natural and commercial fertilizers and artificial drainage. The results of this branch of the work have also been very interesting in showing that there is a mutual dependence between soil fertility and use of water by plants. In connection with the question of soil fertility, the reclamation of alkali lands by means of under-drainage has here been investigated briefly, with the result that it seems probable that alkali lands may be reclaimed by under-drainage, and that, by proper methods of irrigation, they need not again be subjected to alkali conditions.

The conservation of the moisture, already in the soil, has been studied with reference to the stirring of the top soil, the addition or removal of soluble salts, the quantity of water to be added at each irrigation, sub-irrigation, standing water near the surface, and the crops. The consideration of these problems has led to conclusions which, if applied by the farmer, may lead to the saving of one-third to one-half of the water now ordinarily used for the production of the common field crops.

The various methods of irrigation, flooding, furrowing and sub-irrigation, have been tested with results that indicate plainly the relative merits of these methods of supplying water to soils.

THE CROP PROBLEMS OF IRRIGATION.

The relation of water to crops has also been investigated systematically and exhaustively. The total yield of crops has been found to depend not only upon the total amount of water, but also upon the time of application, the frequency of application and the manner of application. The results of this investigation, which will be published in a later article, have been of a more surprising nature, and show the way to an economical use of water in the arid regions. However, there is much to be considered by the farmer besides the actual yield of crops obtained. For instance, with certain crops it may be very desirable to be able to hasten the maturity and the question of being able to delay or hasten the ripening of crops has been studied with most important results.

In another investigation, the relative proportion of the different plant parts—leaves, stalks and roots—as affected by irrigation has been determined, and it has been found possible to produce plants at will with a larger or smaller proportion of any one of these parts than is ordinarily found.

Of prime importance, also, have been the results obtained in the study of the quality of various crops as influenced by irrigation. It has been discovered that the various constituents of plant parts, such as gluten in wheat, starch in potatoes and sugar in beets, may be increased or diminished at will by suitable methods of irrigation. Incidentally, the milling quality of grains grown with different amounts of water, and the cooking quality of potatoes, cabbage, carrots and other vegetables as depending upon irrigation, have been determined.

Of even greater interest than the questions already mentioned are the attempts to breed certain characteristics into plants by controlling irrigation. For instance, the best flour for human food is that which contains a high per cent of gluten, and by irrigation it is possible to increase or diminish this per cent. The attempt has been made to produce grain so rich in gluten that when grown in countries of abundant rainfall where irrigation is not practiced it will yield seed that is also rich in gluten. Can this be done in the case of wheat and other crops, and it seems very probable that it can be, it will

undoubtedly mean that the arid irrigated districts of the world will become the great seed producing centers for those parts of the world where irrigation is not practiced.

These are some of the problems that have been studied at this institution during the last four years and show the general tenor of the investigations.

The crops investigated so far have not been very many, but include wheat, oats, barley, corn, lucern, brome grass, timothy, Italian rye grass, orchard grass, potatoes, sugar beets, peas, onions, cabbage, carrots, hemp, tomatoes and apples. As opportunity allows, other crops will be studied in a similar exhaustive manner.

INCREASING THE IRRIGATED AREA.

As already remarked, back of all these more or less scientific problems lies the greater problem of using the water at our disposal in the most economical manner, and the results obtained show beyond doubt that the application of scientific principles to the art of irrigation will do for irrigation what such applications have done for the great science of agriculture. Specifically, the results of our investigations lead us to assert that even under present conditions without building one new reservoir or adding to the present irrigation canals, the irrigated area may be increased one-third or one-fourth or one-half. With such results the elaborate investigations carried on here for several years past are amply justified. When, in addition it is recalled that there is a strong probability of raising the quality of crops by rational methods of irrigation, far above the quality of crops in humid districts, it follows that all such investigations as those outlined can not be supported too heartily.

EQUIPMENT.

It is evident that such work as has been outlined requires a large and special equipment. In fact, the amount and quality of the work that can be done depend almost altogether upon the means which may be placed at the disposal of the investigators. Three farms have been and are being used in this work—the college farm containing one hundred plats, one-twentieth of an acre each; the Greenville farm containing one hundred plats, one-twenty-fifth of an acre each, and the Frankhaüser farm containing eighty plats, one-twenty-fifth of an acre each. These farms have been laid off into plats so far removed from each other that the water applied to one plat does not affect the soil water of the adjoining plats. Large main and lateral flumes have been built so that the water may be conveyed at will to any portion of the farm and to any one of the plats. A large Cippoletti weir, of the very best construction, is built for each farm to enable the measurement of the water to be made in the most accurate manner. The clock work recording devices for water measurement have been found to be unsatisfactory and have been discarded. Men are now employed to attend to the weirs and to measure the water at frequent intervals with micrometer gauges. All the plats are so ridged that all the water applied to one plat is compelled to soak into the soil of that plat. As far as the means at the disposal of the investigators will allow, the conditions under which the water is applied to these plats are possessed of almost mathematical certainty.

In addition to the three farms, a large vegetation house has been built, containing seventy-eight pots, each one twenty-four inches in diameter and two and one-half feet high. These pots are filled with various kinds of soils in which different plants are grown with varying amounts of water. The vegetation house experiments serve to check the work done in the field, and to furnish data concerning problems that can not well be solved directly on the farm. These pots are placed on small, specially constructed cars, and are kept in the open air day and night, except on rainy days when they are sheltered under a glass roof. Weighing contrivances have been constructed whereby the pots may be weighed at stated intervals and the loss of water under different conditions may be determined.

Then several laboratories are in operation for the chemical, physical and other studies of the soils and crops used in the investigation. Beyond question, the experimental plant for the study of irrigation at the Utah Experiment Station is the only one of its kind in the world.

THE WORKERS.

Such elaborate experiments can not be conducted successfully by one man. The problems are so widely different that various specialists are necessary to handle them all. Three of the departments of the station are therefore engaged in the co-operative study of the principles underlying the art of irrigation. The seeding and harvesting of crops and all the field work are under the direction of the agronomist, Prof. L. A. Merrill. The application and proper measurement of water and all relative work were under the direction, during the first two seasons, of Prof. G. L. Swendsen, now of the United States Reclamation Service, who was succeeded by Prof. W. W. McLaughlin, the present irrigation engineer. The soil moisture work and the chemical studies of the soils and crops are under the direction of the writer, who also has general oversight of the work. In addition to the heads of the different departments, numerous assistants and laborers are employed to look after the details of the work.

Beginning with 1904 these investigations will be carried on in co-operation with the irrigation investigations of the Office of Experiment Stations under the direction of Prof. Elwood Mead. With the support thus given the investigations by the Washington office, it is expected that future investigations will be even richer and more valuable than in the past.

The field is so vast that many investigators must give many years to its study before the art of irrigation can be said to rest on a rational basis.

The report of the work done during the season of 1901, only, has been published (Bulletins 80 and 86). The report for 1902 will soon appear, and the report for 1903 will be published as soon as the mass of data can be systematized and digested.

In succeeding articles will be presented some of the results gained in 1901.

Mr. H. G. Ferrar, manager of the American Beet Sugar Company, of New York, made a trip through Nebraska a few months ago with Secretary of Agriculture Wilson, Henry Wallace, of *Wallace's Farmer*, and a few others. Mr. Payne of the Payne Investment Company, of Omaha, accompanied the party, and secured a few snapshots of the different genetlemen. Among them he secured the one shown herewith of Mr. Ferrar.

THE SCOPE AND PURPOSE OF THE IRRIGATION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

BY ELWOOD MEAD, IRRIGATION EXPERT IN CHARGE.
Courtesy U. S. Department of Agriculture.

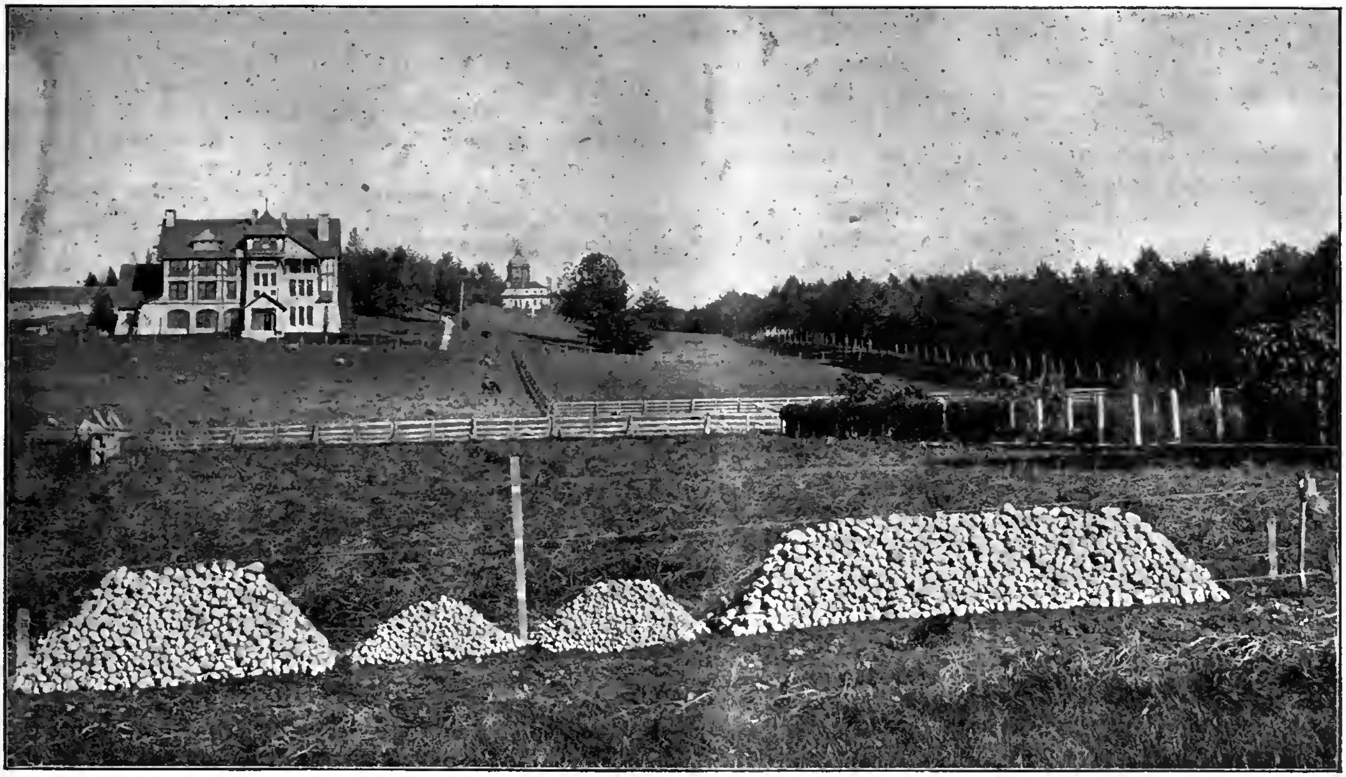
Continued

INSTRUMENTS FOR MEASURING WATER.

In carrying on the measurements of water it was found that the instruments used were in many cases not suited to the work required of them, and were so expensive as to limit their use generally to Government and State work. With the progress of the work of the investigation there has been a growing demand for instruments which will do accurate work and at the same time be within the reach of canal companies and individual irrigators. The instruments most used are the current meter and the register for keeping a continuous record of depth of water at any point. Efforts have been made to cheapen these instruments and at the same time increase their efficiency. Little has been accomplished with the current meter, but the water register has been so simplified as to reduce its cost by more than half without any sacrifice in accuracy. The appearance and method of using these registers is shown in Fig. 2.

LEGAL AND SOCIAL PROBLEMS.

The measurements made to determine the quantities of water used and the losses from canals has another object besides the improvement of agricultural practices. It is a principle of irrigation law, in theory at least, that rights to water are based on beneficial use; that is, a person or company can maintain a right to only so much water as he or it can put to a beneficial use in irrigation. It is of first importance, therefore, to know how much water is needed to grow crops on a given area, in order that courts and boards of control may intelligently determine the amount of rights to water, and officers charged with this duty be able to prevent wasteful use by those who have early rights or a desire to monopolize the supply. Because of the lack of this information, rights to water have too often been established without any regard to the volume of the stream, the capacity of canals, or the needs of the land to be irrigated. The attempt to utilize such excess rights can lead to nothing else than continued litigation and trouble. The facts gathered in these investigations are already being eagerly sought as a guide in the establishment of water titles, and they are certain to prove one of the most effective agencies in preventing erroneous or excess decrees in the future.



IRRIGATION INVESTIGATIONS--RESULTS OF IRRIGATION IN WISCONSIN.
The two central piles show the yield and size of potatoes grown on unirrigated rows. The two end piles show the yield and size of potatoes grown on irrigated rows.

A knowledge of the extent of the losses from canals is also necessary to the proper distribution of the supply. Appropriations usually contemplate the measurement of the volume allowed at the head of the canal, hence the amount granted should be great enough to meet all the necessities of crops and also to allow for losses in transit. If this estimated loss is too large the volume taken in at the head gate will be greater than the needs of the land irrigated, but if too small irrigators will suffer. Excessive allowance for these losses puts a premium on poor construction, hence data is needed to show what are reasonable losses and to prevent anything above this. Where losses can be stopped appropriations should be cut down in order to compel ditch owners to make them economical water carriers. Losses which can not be stopped should be provided for.

IRRIGATION LAWS.

Along with the observations and experiments in the use of water has gone a study of the laws and customs which control its distribution. This study reveals the fact that the development of irrigation law has not kept pace with irrigation engineering or agricultural practices. As the need and value of water has increased, engineers and farmers have found ways to conserve the supply and economize in its use. But it is too often the case that this increase in value has only added to the uncertainty as to titles, since it presents greater inducements or temptations to those holding inferior rights to try to secure a larger share of the supply. The absence of tribunals for the final establishment of water titles, and the lack of public control over the division of streams, puts upon the holders of the older and better rights the burden of protecting their interests either by force or in the courts. The greatest need of irrigation is legislation which will end this uncertainty and controversy, but from the nature of things such legislation is hard to secure. Conservative legislative bodies are slow to act, and they often have not the information on which to base intelligent action, even if they have the desire to do all that should be done. The conflicting views of appropriators of water make it impossible to enact any effective law which will not be strongly opposed, or which will not work hardship to some individual. The work of this office is limited to collecting and publishing information, with discussions by experts whose broad views enable them to better interpret the facts than is possible where details and local interests obscure the general policies which should prevail.

Studies of irrigation laws and customs have been made in connection with the measurements of water in all the arid States and Territories. Comprehensive studies of irrigation laws and customs have been made in California and Utah. A report dealing with the agricultural situation in California has just been published. This study was undertaken in response to a petition from the citizens of that State in the hope that a clear statement of existing conditions would help toward the enactment of a comprehensive code of irrigation laws.

A similar study has been made in Utah, and the reports of the different observers are about ready for publication. These reports will show that titles to water in that State are far from being stable or secure and that there is urgent need of a cheaper and simpler method by which they can be permanently settled.

The conditions found in California and Utah are not peculiar to those States. They are common to nearly all the arid States. Their betterment is the first step in the successful or the complete use of Western water supplies. As has been said, the work of this office can not extend to the enactment of laws. It must stop with showing existing conditions and pointing out remedies for the evils found. With this end in view the laws of not only our own States, but of Canada, Australia, Europe, and Egypt, are being studied in order that the best lessons from the experience of all the world may be within the reach of those who must enact the laws which will protect and encourage investment in irrigation enterprises. An agent of the department is now in Egypt studying the legal systems in vogue there.

ORGANIZATION OF IRRIGATION INDUSTRIES.

Not less important than the system of irrigation laws is the character of the organizations which control the water supply under these laws. Irrigation is essentially a co-operative industry. In its beginning small ditches were sometimes constructed by individual farmers, but opportunities for such construction are practically all utilized. The large canal covering the lands of many farmers is in most remaining cases the only possible one; hence the existence of the industry calls for organization and co-operation, and in most cases not only co-operation of farmers, but of capitalists as well. The problem to be solved here is how to secure returns upon the capital invested and at the same time keep the land and water within the reach of the poor man, the only man who is seeking for a new home. This problem has not been solved in this country. It is one which must be solved before irrigation can go much further.

Under the laws of many States water rights are granted to the canal companies. In those States the rights of the farmers depend on the form of the organization of these companies rather than on the laws. The reports of this office show that the peace and prosperity of many communities, as well as the economy with which water is used, depend almost wholly on the rights of the individuals under the companies. This study of organization and its effect on development is being carried on wherever the measurements of water have been made.

In this connection it seems proper to reiterate the views expresesd in a former report on the subject of water rights. The first step in future development should be to reach an enlightened agreement regarding the true character of these rights. The idea of private ownership in water apart from land can not prevail without creating institutions essentially feudal in character. To give to companies or individuals the control of streams, and make the farmers who use those streams dependent for their rights on the conditions which these companies impose in private contracts, is to make the water company the practical owner of the land it serves and the irrigator and farmer a tenant. A proposition which would contemplate turning over all the land of the West to private monopolies and making those who have homes upon it dependent upon these monopolies would not command popular support, but the idea of private ownership in water, amounting to a virtual monopoly of this vital element, has been permitted to grow up in some sections of the West. To a certain extent it has obtained recognition in legislation and protection in judicial decrees and decisions. Such a doctrine meets with no favor in other irrigated lands, and should in this country give place to the more just conception that rights to water should be restricted to the right of use, and that ownership should not be vested in either companies or individuals, but in the land itself. When this principle is adopted the control of water is divided like the control of land among a multitude of proprietors; water monopoly is impossible, and no other abuse or injustice is encouraged. Years of experience in other lands and the limited experience of this country have abundantly proven that peaceful and orderly development can not be realized except as water and land are united in one ownership, and canals treated as public or semipublic utilities rather than as a means of fastening a vicious monopoly upon communities.

IRRIGATION IN THE SUBHUMID PORTIONS OF THE UNITED STATES.

The subhumid portions of the United States possess certain advantages in the employment of irrigation which must in time greatly extend its application in this section of the country. There is a greater rainfall and a more humid atmosphere than in the arid region, so that a given water supply and a canal of given dimensions will irrigate more acres than in the region wholly arid. Much of the subhumid district east of the Rocky Mountains is remarkably well suited to the distribution of water in irrigation. The slope of the country away from the mountains is about what is needed for the construction of canals and the distribution of water over the ground. The practical obstacles to be encountered, either of an engineering or agricultural character, are less, as a rule, than in either the arid or humid sections, and the cost of supplying water is proportionately reduced. Important studies have been made during the past year in this region by Prof. O. V. P. Stout, of the Agricultural Experiment Station of the University of Nebraska, acting under the direction of this office. This station is in a section where lands have been cultivated for many years, and where agriculture is a demonstrated success without the aid of irrigation. The question to be settled is whether the use of water on general farm crops will give sufficiently increased yields to repay with a profit the cost of providing the water supply and distributing it over the land. Results thus far secured show that it will. The maximum yield of corn in this locality without irrigation is about *40 bushels per acre,* while the lands irrigated during the past year yielded *from 40 to 60 bushels per acre,* with a maximum yield in rare instances of *90 bushels per acre.* Two adjacent fields, one irrigated and one depending on rainfall alone, *yielded 66 bushels and 20 bushels per acre,* respectively.

The methods of diverting and applying water were those of the ordinary irrigator; the soil and climate were typical of the territory which extends westward from the Missouri River for 250 miles, and the results can fairly be taken as representing what may be expected in seasons of scanty rainfall throughout the greater part of the subhumid district.

(To be continued.)

Wesley A. Stuart, of Sturgis, S. D., is a gentleman who has been prominent in irrigation matters and has always shown an active interest in the National Irrigation Congress. His picture shown in this column would lead one to pick him for a New York banker rather than an attorney from the wind-swept prairies of the Dakotas.

Gen. W. H. H. Beadle, president State Normal School, Madison, S. D., was active at the Irrigation Congress held at Colorado Springs in 1902 and has been prominent in educational work in his State.

GRADUATE HONORED.

Prof. Elwood Mead Receives the Highest Honor at Disposal of Purdue University.

Purdue University recently conferred the highest honor at its disposal and recognized an engineer of distinguished merit in conferring the honorary degree of Doctor of Engineering upon Elwood Mead, chief of the Government bureau of Irrigation. This degree is rarely given and only to persons of distinguished attainments in engineering. It has not been given at Purdue before.

Mr. Mead graduated from Purdue in 1882, was appointed professor of mathematics in the Colorado Agricultural College in 1883, received the degree of Master

ELWOOD MEAD

of Science from Purdue in the same year, and the degree of Civil Engineer from the Iowa Agricultural College soon after. He inaugurated the course in irrigation engineering at the Colorado college and soon became a recognized authority on the subject. He bore an important part in securing legislation in Colorado on water rights. Later as territorial engineer for Wyoming he was largely concerned in shaping the law and practice of irrigation. Recently he has been made special agent of the Government in charge of irrigation investigations.

His work on irrigation institutions is a recognized authority on the subject.

Mr. Mead has been for many years a member of the American Society of Civil Engineers. He is professor of irrigation instruction in the University of California and also delivers a course of lectures each year at Harvard university.

Our readers who are acquainted with Professor Mead will be pleased to learn of the honor conferred. We are showing herewith photo of the gentleman.

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,
Expert in Drainage and Irrigation, U. S. Department of Agriculture.

From Farmers' Bulletin No. 187, Courtesy U. S. Department of Agriculture.

(CONTINUED.)

FILLING THE TRENCHES.

Enough earth should be thrown upon the tiles after they are laid to secure them in their position. This work should be intrusted to a careful workman, who should see that moist earth is thrown around and over the tiles in such a way that they will not be moved by any subsequent filling. After this has been done the filling may be completed in the most convenient and expeditious manner. Where the land is cultivated, ditches can be filled rapidly with a plow pulled by a team on each side of the trench. The evener used upon the plow for this purpose should be sixteen feet long. The excavated earth, it has been assumed, has been thrown in about equal quantities on each side of the ditch. In meadow or sod land a V-shaped scraper with the point behind, made for the purpose, can be used to fill from both sides at one passage without disturbing the turf. In order to use either of these methods satisfactorily the earth should be dry enough to fall apart when moved, instead of sticking together in a gummy mass. Where the soil is too wet, soft, or sticky to be moved by the means just described, the filling may best be done by hand labor with a potato hook, or filling hook, which is in the form of a hoe with tines instead of a solid blade. The land should be cultivated the next year or two after being cut up by drains, if practicable, because the earth is loose and continues so for a year, preventing grass from taking quick and permanent root. This is not the case with cultivated crops, as the most luxuriant growth may usually be found directly over the drains.

DITCHING MACHINES

During the sixty years in which tile drainage has been practiced in this country, many machines for opening the trenches for tile have been invented and manufactured, which, when tested, failed to meet the requirements. There are many difficulties to be met in the digging of farm drains. The soil is often soft and sticky; at other times it is hard, and in some localities contains gravel, stone, and hardpan. Deep cuts must sometimes be made; muck ponds and shaking bogs must be gone through. In short, the difficulties to be overcome by the inventor of a tile-ditching machine can hardly be appreciated by any one acquainted with practical draining.

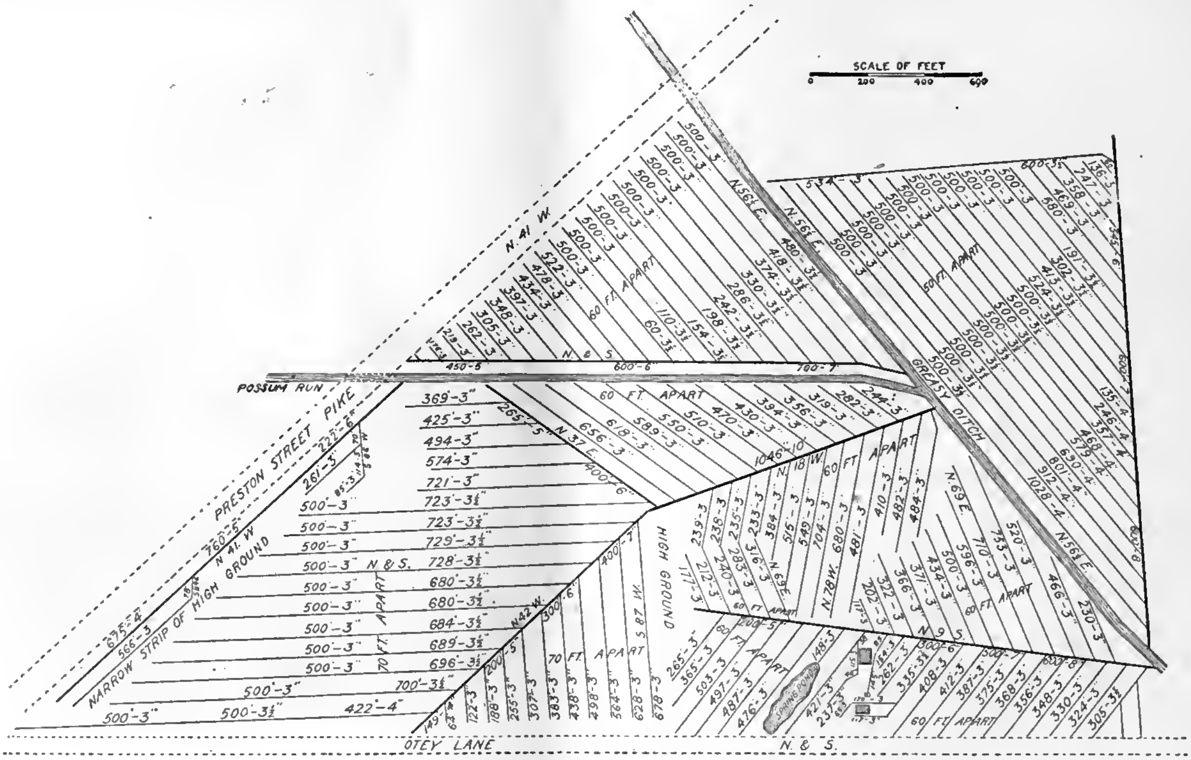


FIG. 15.—Map showing the drainage of 128 acres of clay land in Jefferson County, Ky.

Doubtless no machine will ever be made that will meet the requirements of all kinds of land. There are, however, a few which seem to work satisfactorily where the ground is sufficiently firm to support the machine and where the earth is not extremely mucky and sticky. Where draining of considerable extent is proposed, the adaptation of these machines to the work required may be profitably investigated.

SOME OF THE RESULTS TO BE EXPECTED FROM UNDERDRAINS.

After heavy rains the surface usually begins to dry first directly over the drain, the drying process extending on either side until the limit of action of the drain is reached. This limit, as previously explained, will depend upon the closeness and structure of the soil. The physical characteristics of the soil also affect in a remarkable degree the quickness of the action of drains, so that their effect as regards both time and extent varies greatly with the kind of soil acted upon.

Nevertheless, there are but few soils which will not respond to underdrainage if properly treated.

The farmer may reasonably expect to begin working his land a week or ten days earlier in the spring with the soil in good condition than if it were not drained. He may expect that his winter grain and clover will not be injured by the heaving of the soil, as is the case with wet clay soils. He may expect his crops to endure the drought of summer with less injury than those on undrained land. He may adjust the rotation of his crops irrespective of the fact that some portions of the field are wet while others are dry. He may continue his cultivation during the summer without being obliged to avoid or go around portions of the field which, by heavy rainfall, are made too wet for profitable cultivation.

COST AND PROFIT OF TILE DRAINAGE.

The ultimate question that must be answered in regard to drainage is, "Will it pay?" The agriculturist can usually answer that question if he can ascertain what the cost of the work will be. From what has been said regarding the necessity of varying the distance between drains to accomplish the same work in different classes of soils, it will be seen that the cost must necessarily vary greatly. The price of labor and material in different sections of the country is also subject to constant change. Farms of which parts have natural drainage and parts require artificial drainage may be improved at a cost of $6 to $8 per acre for an entire farm where the outlets are provided by nature. In this case the improvement consists in draining the wet land and fitting it for profitable cultivation. On farms which require drains at uniform distances of, say, 100 feet, the cost may be $14 per acre, while on those lands requiring drains thirty-three feet apart the cost will be $22 to $30 per acre. The cost will vary, of course, according to the price of material and labor.

Tiles are sold by the thousand feet, each tile being one foot long except sizes above twelve inches in diameter, which are usually made eighteen or twenty-four inches long. The prices given below are those prevailing in the East and Middle West. Prices in the far West are quoted much higher than those here given. The following may be regarded as an average range of prices for tile at the factory, and in some instances at a railroad station 100 miles distant from the factory:

COST OF TILES OF DIFFERENT SIZES PER 1,000 FEET.

3-inch tiles	$10.00	to	$ 12.50
3½-inch tiles	12.00	to	15.00
4-inch tiles	15.00	to	20.00
5-inch tiles	20.00	to	27.00
6-inch tiles	27.00	to	35.00
7-inch tiles	36.00	to	50.00
8-inch tiles	45.00	to	60.00
10-inch tiles	60.00	to	110.00
12-inch tiles	90.00	to	150.00

The excavating of the ditches is done by workmen who furnish their own tools and contract to dig and grade the ditch, lay the tiles, and cover them securely with a few inches of earth, at a certain price per rod. The price of such work in soils which may be easily handled with the spade, that is, those having no stones and not so hard as to require the use of the pick, is about 25 cents a rod for ditches averaging three feet deep and for tile not exceeding six inches in diameter. Such ditches may range from two and one-half to three and one-half feet deep, making an average of three feet. Where the range is from two to two and one-half feet, 20 cents a rod is considered a fair price. For depths from three to five feet an additional price of 1 cent per rod for each inch of depth below the average of three feet is charged. That is, a ditch averaging three and one-half feet deep, will cost 31 cents a rod; one four feet deep, 37 cents. It is the practice of workmen to accept the average depth of the entire line as the depth upon which settlement for the work is to be made. For tiles eight to twelve inches in diameter, the price is 30 cents for the three-foot depths and 1½ cents an inch per rod for additional depths.

These statements should serve as a general guide only in making estimates. The hauling and distributing of tile and the tough and hard clays encountered in many localities will necessarily make considerable variations in the cost of completed drains. The farmer may often do much of the work with the labor he regularly employs at a less cost than the price a contractor will make, especially if the drains are to be laid in hard or stony soil.

The profit derived from draining wet land is more apparent when we consider that the same labor that is bestowed upon undrained land will produce from 20 to 50 per cent greater yield of cereals where the land is drained. As a rule, lands to be drained should have a large supply of fertility, drainage being the only thing needed to make them productive. It has, however, been found by experience that soils which require artificial fertilizing frequently become very productive when drained, since the fertilizers applied are able, through the effect of drainage upon the soil, to bring into use natural resources hitherto hidden and unavailable.

The writer has known of many thousands of acres of land that have been drained, and has never known of an instance in which the money spent for drainage, when thoroughly done, did not pay a large return on the investment. An annual profit of 25 per cent is not at all uncommon. The question should be looked at in the following way: If the farmer owns the land he must pay the taxes, keep up the improvements, and procure the necessary help and implements for cultivating it. If there is land which he cultivates at a disadvantage, because it is too wet to yield a full crop, or possibly yields none at all, proper drainage will cause this land to yield a full crop without the expenditure of any additional labor, seed, or capital, and the entire increase may properly be regarded as the profit of drainage. A few examples which have come under the writer's personal observation will help to emphasize these general statements.

A twenty-acre field which usually yielded only twenty-five bushels of corn per acre was tile-drained at a cost of $10 per acre. The yield after drainage was not less than sixty bushels of corn per acre, and the yield of other crops in the rotation was in proportion. This gain of thirty-five bushels, at 30 cents per bushel, the selling price of corn at that time, paid for the entire cost of drainage the first year.

(To Be Continued.)

IRRIGATION EXPERIMENTS IN ARIZONA.

Investigations Covering a Period of Four Years at the Experiment Station Farm at Tucson.

BY PROF. ALFRED J. M'CLATCHIE,
Agriculturist and Horticulturist of the Arizona Agricultural Experiment Station.

[Continued.]

A record has been kept of the water applied to the principal crops grown upon the station farm during 1900 and 1901. For determining the amount applied at each irrigation, gauged flumes were installed at necessary points upon the farm, and the length of time water ran upon a given crop at each irrigation, and the depth in the box, noted and recorded by the employe doing the irrigating. From the records thus made are computed the amounts applied to the crop. During 1900 no attempt was made to ascertain the cost of production and the gross value of the crop, as was done during 1901.

RECORD FOR 1900.

Three of the crops harvested during this year were sown during November and December of 1899. Most grain sowing is done during the above months, but the planting of beets during that period is unusual. Had cold rainy weather followed the sowing of the beets, they would not have fared so well.

TABLE V.—CROP RECORD FOR 1900.

Crops	Date of planting	Date of first irrigation	Date of last irrigation	Number of irrigations	Depth of water applied	Date of harvesting	Yield per acre
					FEET		LBS.
Barley hay	Nov. 7	Nov. 10	Mar. 18	3	1 6	Apr. 8	8400
Wheat hay	Nov. 10	Nov. 11	Mar. 19	4	2.1	Apr. 20	6800
Cowpea hay	June 6	June 9	Sept 9	9	3.8	Sept. 19	7200
Wheat (grain)	Nov. 4	Nov. 5	Apr. 14	4	2.2	May 10	2400
Sugar beets	Dec. 26	Apr. 1	June 26	5	2.5	July 30	29000
Sugar beets	Jan. 23	Apr. 3	July 15	5	2.5	Aug. 10	21000
Potatoes	Jan. 17	Feb. 17	May 2	4	2 0	May 25	4000
Potatoes	Feb. 7	Feb. 17	May 2	4	2.0	May 31	3200
Watermelons	Mar. 17	Mar. 29	July 15	13	3.2	July	26000
Cabbage	Aug. 11	Sept. 15	Feb. 25	16	5.0	Jan-Mr.	14000
Cabbage	Sept. 29	Nov. 22	May 9	16	5.0	Mr-My.	13400
Onions	Sept. 16	Sept. 16	July 11	29	6.2	July	5200
Green peas	Nov. 28	Dec. 10	Mar. 22	6	2.4	April	4400

In the above table, there is included in the amount of water applied to produce the crop the water applied previous to plowing the land for the reception of the seed. This amount was usually about .6 of a foot. To be sure, much of it would be lost before the crop would be sufficiently developed to begin to use it, but this irrigation previous to plowing is in most cases a necessary part of our farming operations, and the water thus used should be counted as part of that necessary for producing any given crop.

The atmospheric conditions seemed to be unfavorable for the proper development of many crops during the spring of 1900, causing low yields. regardless of the amount of water applied. Hence many of the yields (especially of vegetables) can not be considered indicative of what the same amount of water would produce during an average season.

RECORD FOR 1901.

In addition to keeping a record of the water applied during the growing of a crop, a record was made of the amount applied previous to planting the crop. In some cases, as of melons and corn, part of this amount is applied previous to plowing and part of it after plowing, a short time before planting the seed. As was noted in the case of the previous year, two of the grain crops were sown during the previous year.

From a record kept of the work done on each crop, and from data secured from farmers, an estimate, believed to be fairly accurate, was made of the cost of the production of each crop grown during 1901.

The gross value of the crop per acre was estimated chiefly from a record of actual returns from produce sold. In case a crop, or a portion thereof, was not sold, it was credited with what it would have brought upon the market at the time it was harvested.

It will be observed that some crops give a much higher net return per acre foot of water applied than others. This is a matter of considerable importance to a water user. It is to his interest to obtain as large a net return from his investment in water as possible. It is to his interest to grow, to the extent the market will warrant, the crops that will give him the greatest net return for the water used. If potatoes, or tomatoes, or melons give a higher net return annually than grain, then to grow one of the above instead of grain would be a good business policy.

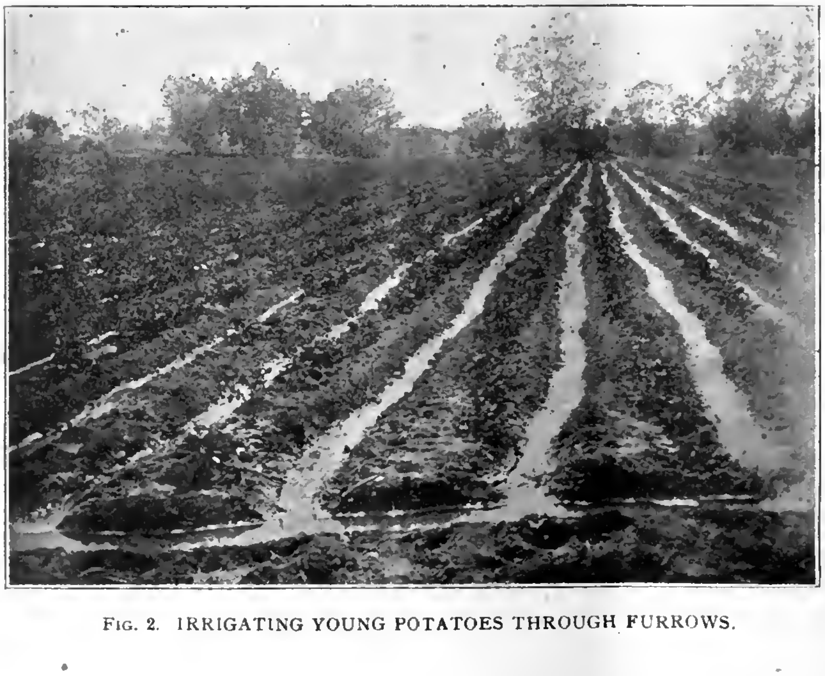


FIG. 2. IRRIGATING YOUNG POTATOES THROUGH FURROWS.

It is also important that such a variety of crops be raised as will result in using the water available, at all times of the year. Grain requires water during one part of the year, potatoes during another, melons during a later portion, and corn and some other crops during still later parts of the year. Diversified farming is likely to result not only in using the water throughout all the year. but in higher net returns from the water used.

The individual farmer is interested in the net returns he obtains, but the community is equally interested in the gross returns from a crop. A large gross return ordinarily indicates that a large proportion has been of necessity spent for labor. A crop that furnished labor for a large number of workmen is a more valuable one to a community than one grown with little labor. The more laborers required at farming operations, the

greater the demand for all that the merchant has to sell, and all that the farmer is producing. The longer the region is cultivated, the more evident it is likely to become that much can be accomplished along the lines of material progress, by more diversified and more intensive farming.

METHOD OF IRRIGATING CROPS.

Most irrigating is done in the region by one of two methods—through furrows, or by flooding. The furrows may be permanent or temporary. Plants such as strawberries and small vegetables that require the frequent application of small amounts of water are by most growers irrigated through furrows that are more or less permanent. Some farmers break up by cultivation the crust that forms on the surface, while others simply hoe from the furrows and the intervening ridges the weeds that grow there. This method of irrigation should be resorted to only in the case of such crops and under such climatic conditions as to make it difficult to irrigate by any other method.

Running water through temporary furrows that are cultivated up after each irrigation is to be preferred wherever practicable. Experience at the farm shows that this is the method by which all crops that can be so irrigated should be irrigated. The water applied penetrates the soil, and a smaller percentage is lost by evaporation than by any other method. Since the soil mulch formed by cultivation prevents the rapid escape of moisture, crops will need less frequent irrigation by this method than by any other.

In irrigating by the furrow method it is important that the streams permitted to run in the furrows be small. Just enough water to cause the stream to creep slowly along should be turned down each furrow. The soil will thus become thoroughly saturated and little water will escape at the lower end of the field. The more slowly the water makes its way down the furrows, the better, provided it gets through during the time that irrigating water is available. If so large a stream is permitted to run in each furrow that the water reaches the lower end quickly, the sides are thus made less pervious, and a large percentage of the water escapes at the lower end—water that would percolate into the soil, if it ran more slowly. For equalizing the flow of water into the upper ends of the furrows, straw or other similar coarse material will usually be found serviceable. If something is not used to prevent the washing of the soil, the tendency is for too much water to find its way down some furrows, and too little down others.

In the case of crops that cover the ground, such as alfalfa and grains, flooding is the method in general practice. In this region these crops are flooded by running a large stream of water between two ridges (commonly called "borders") thrown up with a plow, about thirty feet part. Between these two ridges the water being applied spreads out into a broad shallow stream that flows the length of the field. Waste ditches at the lower end of the field carry off water that flows from the ends of the lands. The first time a field is irrigated after sowing, and to some extent at later irrigations, it is necessary to impede the progress of the stream of water and cause it to spread over the whole surface, where, on account of the slope of the land, it is inclined to run in a narrow stream. This is done by throwing up across its course earthen ridges called "tappoons." If these tappoons are properly made they will usually cause the water to flow where it is desired during several subsequent irrigations.

Before plowing unoccupied land it is commonly irrigated by flooding. Experience at the farm shows, however, that a better way is to run the water through furrows made two to three feet apart, the distance apart depending on the nature of the soil and the length of the field. The more slowly the soil takes water, and the shorter the field the nearer together the furrows need to be. At the farm these furrows are made with an adjustable three-shovel furrower, by means of which the land can be furrowed as rapidly as it can be ridged ("bordered"). Less water is required by the furrow method, less labor is required to handle the water, and less water is lost by evaporation. Moreover, the whole surface of the soil does not become crusted over or baked as it dries, as does land that is irrigated by flooding. In some cases land may be too hard to furrow, and flooding be therefore necessary.

In discussing the irrigation of individual crops in the pages that follow, the methods recommended are those that experiments at the farm indicate are best.

Alfalfa seed may be sown in dry soil or soil that has been previously irrigated, the latter method being usually preferable. It is better to have the soil in such condition as to moisture and tilth that the seed will germinate and the young plants appear without further irrigation being necessary. If the soil was dry when the seed was sown, or is not sufficiently retentive of moisture, or if, on account of the nature of the weather that follows seeding, the soil dries before the plants appear, water should be applied as promptly as practicable. The young plants must have plenty of water in order that a good stand may be secured.

The seeding may be done at any time during the period from October to March inclusive, but the best times are October 1st to November 10th and January 15th to the end of February. The young plants being sensitive to both low temperatures and excessive heat and aridity, a good stand can best be secured from the use of a given amount of water by sowing during the seasons above recommended.

After the young plants appear, they should be given water frequently enough to keep them growing steadily. The application of water twice a month, during the first three months is usually ample to secure a good stand. If sown during the winter season mentioned above, a light crop may be cut three or four months after sowing. After this, the application of water once a month is sufficient the first season. It is probably not economical to apply much water during November and December, but beginning with January, water may be applied freely to advantage, under the conditions existing in the region of the farm. Where water is available at all times of the year when needed for alfalfa, it will probably be better in most cases to postpone the free application of water until the first of February. Alfalfa being very deep-rooted, water to the depth of two feet may be applied to advantage just before, or during the early part of the growing season. After cutting the first crop, water may still be applied freely to advantage. After cutting the second crop the application of one-half to two-thirds of a foot of water will be sufficient for the production of each subsequent crop. But the amount that will be necessary to secure a good growth during the summer will depend very much upon the amount applied during the winter. If the field has been thoroughly wet during the latter season, two good crops can usually be cut without irriga-

tion between the first and second cuttings; and in some cases a third, or even a fourth crop can be cut. During the cutting season, the best time to apply water is a few days previous to mowing. By this method, the new growth starts promptly after each crop is removed.

Alfalfa is especially adapted to a region with a fluctuating water supply, such as we have. When once established, the crop produced varies with the water applied, within certain limits. Water may be applied freely during the winter when it is abundant, and withheld entirely during the summer. In fact, it will live during several average years without the application of any irrigating water. One field that has been under the observation of the writer has not been irrigated for over four years, yet many of the plants are still alive, a crop having been cut each spring the first two of the four years. Up to a limit of about six crops of two tons each, the amount that a field of alfalfa will yield increases with the quantity of water applied. A total of four to six feet can be applied to advantage during the year. It is not easily killed by drought, but it thrives under and responds to irrigation as satisfactorily as does any crop grown.

(To Be Continued.)

METHODS OF PREPARING LAND FOR IRRIGATION.

The Office of Experiment Stations, United States Department of Agriculture, will soon issue a bulletin describing methods of preparing land for irrigation and applying water to crops in different sections of the arid region of the United States. In this bulletin the methods of getting rid of sagebrush, smoothing the ground, building laterals, and distributing water over fields as developed by the experience of farmers in irrigated districts are brought together and described. The tools and implements used are illustrated and the cost of the work, based upon actual examples in different States, is given. The purpose is to afford beginners a reliable guide both as to the cost of bringing wild land under cultivation and methods best suited to different soils, climates and crops. The facts included in this bulletin have been gathered by the irrigation investigations of this office, acting in co-operation with the State Experiment Stations and State Engineer's offices.

This bulletin brings out the fact, not well understood, that the cost of preparing land for irrigation is in many instances greater than the cost of building ing canals and reservoirs. Detailed figures of the cost of checking land show that it varies in certain districts in California from $9.96 to $18.08 per acre. This is more than twice the cost of the canal systems in the San Joaquin valley, California, which is given in the report of the Census Bureau for 1902 as $4.99 per irrigated acre. Where the preparing of land is contracted for the cost of checking varies from $7.50 to $20 per acre. The price of preparing land for flooding is much less—but is $5 per acre in Wyoming. The need of a better understanding of this particular branch of irrigation practice is becoming more and more important. Reservoirs and canals are but means to accomplish a purpose. That purpose is to increase the products of the soil. The value of the ditch or reservoir depends upon the acreage of land which it will serve and the increase in the value of the products which the use of water will bring about. The time is coming when the most important problems connected with irrigation will be the best means of applying water, and not, as at present, those of canal and reservoir building.

About thirty different methods of applying water are now in use. This does not mean that there are thirty distinct systems, but includes the different ways of preparing land by checking, compartments, deep and shallow furrows, flooding, sprinkling, and subirrigation. The bulletin gives some of the results of a series of tests of different methods of applying water and the difference in loss of water by evaporation in deep and shallow furrows and in flooding. About one and one-half times as much water was needed to irrigate an acre of land by flooding as was required in furrows twelve inches deep. About one and one-third times as much water was needed to irrigate in furrows three inches deep as in furrows one foot deep. A saving of one-third of the water by the adoption of a better system would mean not only increased profits to farmers but a large increase in the acreage which could be irrigated from canals or reservoirs.

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EDWIN F. ABELL, head of the company that publishes the Baltimore *Sun*, died in that city February 28, aged sixty-three years. His father, A. S. Abell, was the founder of the *Sun*, which dates from 1837, and the deceased was the last surviving son, having had the management of the paper for ten years past. His death was, in a measure, brought on by grief and shock following the Baltimore fire.

THE *Irrigation Age*, published monthly in Chicago by the D. H. Anderson Publishing Co., has absorbed *Modern Irrigation*, Denver. There are five publications in the United States devoted to the subject of irrigation, and the *Irrigation Age* leads them in point of circulation, being credited with a monthly average of 22,100 copies for 1903 in the Roll of Honor. The consolidation gives a further increase. The Denver publication made no statement of circulation, and was credited with H—exceeding 2,250 copies. The *Irrigation Age* is nineteen years old, and is said to have readers in all parts of the world among individual irrigators and irrigation corporations.

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We are reproducing herewith notice which appeared in the columns of PRINTER'S INK, the leading authority in the advertising field, for which we wish to thank the publishers of that journal and at the same time call attention to the fact that the combined circulation of the two journals is considerably more than the figure named.

THE PRIMER OF IRRIGATION.

CHAPTER XV.

SUB-IRRIGATION—DRAINAGE.

(Continued.)

Infiltration, or seepage, as a method of irrigation is included in this chapter because it is practically sub-irrigation.

The drainage here referred to is that system of carrying off the surplus or excess of water through underground conveyances, when the same is connected with a system of sub-irrigation. Drainage proper will furnish matter for a special chapter on the subject.

Irrigation by infiltration, or seepage, is effected through following the configuration of the land, by means of flowing or sleeping water seeping through or into the soil from ditches, canals, or pipes, uncovered or covered, but located below the surface of the ground. The water spreads out, seeps or soaks out from the conveyance fan-like into the soil from the sides and bottom of the ditch, canal or pipe, and, following the law of gravity, descends or ascends in accordance with the law of capillary attraction.

Infiltration rests upon the principle of the permeability of the soil, and hence, this method of irrigation is not always as beneficial as those already mentioned, for the reason that it consumes a large quantity of water without supplying the soil with a uniform humidity.

Unless, however, and here are two occasions when infiltration is more economical and beneficial: When the water in the trench, or ditch, or underground conveyance is running water, and when it reaches the roots of the plants intended without spreading out where it can not be utilized.

The advantages of underground or sub-irrigation are too numerous to be ignored. By this system, land too elevated to be reached by water through other means may be transformed into fertile tracts. In the case of hill land it is admirable for cereals, and also on lands where weeds abound. It lends an invaluable aid to a series of special cultures, such as grapes, olives, oranges and citrus fruits generally, likewise in gardening. It enables steep land to be cut into terraces which irrigation water generally could not penetrate to a sufficient depth. In addition to these advantages, the application of underground water on arid or waste land covered with sand or gravel, permits the propagation and cultivation of profitable productive plants which would otherwise perish through dryness of sub-soil. Finally, a well arranged system of sub-irrigation operates as a drainage system as well as for irrigation.

The nature of the soil is more important than the configuration of the ground in sub-irrigation. In this respect, hard impenetrable soils should be avoided for irrigation by infiltration. Experience alone can guide the irrigator in establishing his system of deep ditches, the main point being always to provide for moistening the soil uniformly.

Furrow irrigation applied to cultivated land is similar to infiltration. Running water into furrows and then cultivating the soil over them is a very common method of irrigating by infiltration, and it is suitable for shallow rooted plants, corn, and tubers generally. The pulverized earth forms a mulch which obviates rapid evaporation and enables the water to seep into the soil in every direction before drying out. It is also adopted on a large scale in orchards, vineyards, nurseries, for small fruits and in flower and vegetable gardens where deep irrigation or sub-irrigation proper would not be effective. In all such methods of irrigation it is well to provide that the water or surface wetness be prevented from extending as far as the plant proper, and restrict it to the service of the roots. It is considered more efficacious than direct irrigation, for the reason that the humidity is imprisoned around the roots and evaporation is perceptibly retarded.

It is in the kitchen garden, applied to the culture of root plants, that irrigation by infiltration attains marvelous results. It is the only system of irrigation that enables plants to obtain the greatest quantity of nutritive matter from a given surface. The soil is never at rest; one crop may immediately succeed another, growth continuing all the year around without interruption. It is, in the hot arid regions, equivalent to hothouse culture, so far as luxuriance of growth is concerned, but the crops possess a quality of excellence unknown to forced culture.

SUBTERRANEAN CONDUITS.

Although infiltration is sub-irrigation, many persons limit the system of sub-irrigation to the conveyance of water through underground pipes, tiles or conduits. This method of irrigation is very ancient in its application to special cultures, or to utilize liquid fertilizers. When the volume of water is limited, the soil too porous for surface applications, the method of applying water to the roots of plants through subterranean conduits is very successful in its results, but only, let it be said, for very profitable plants. In general, the great expense attendant upon the installation of a system of underground conduits has prevented the common use of this system of irrigation, ordinary infiltration as above described having been found satisfactory.

But the constant pouring of water upon the soil in many of the older irrigated districts in the arid region, has resulted in creating a water table near the surface, so near in fact that formerly fertile tracts of land have been converted into swamps. Hence, drainage has become a problem necessary to be solved if fertile lands and profitable orchards are to be saved from destruction, and it is gradually dawning upon the minds of irrigators that where there is a system of sub-irrigation there is also a system of drainage ready at hand.

The writer advances the proposition founded on long experience in other countries of similar soil, climate and meteorology as the arid and semi-arid lands of the west, that sub-irrigation and drainage may well go together, and that if tiling or other media be so arranged in underground conduits, they will serve a double purpose, one highly economical and productive of good results. The conditions, indeed, are identical. The water passing through the drain pipes is surplus water, which may quite naturally be used over again as is the surplus water from a surface ditch, or that from overflowed land.

Nearly a hundred years ago the scientist Fellenberg put in at the agricultural establishment of Hofwyl, near the city of Berne, a system of sub-irrigation

through subterranean conduits, for the purpose of moistening the fields in dry periods, when the spongy soil of the gardens commenced to dry and crack, and when the turf was not sufficiently packed to permit surface irrigation.

These underground conduits were so arranged as to serve two purposes: to carry off drainage water, or to retain it for moistening the soil. To accomplish this end the pipes were cut at fixed points by a mass of clay which was traversed by a drain which served as a communication between the ends of the conduit, and which could be closed by means of a movable plug or valve. To cause the water to ascend or flow into the soil, it sufficed to stop or plug up the tubing below the point to be irrigated, and the water flowing through the drain rose to its level and flowed into ground by infiltration.

The idea was approved in England, and in 1839 Fellenberg's system was adopted, and irrigation by infiltration came into common use, largely, however, for the purpose of flowing liquid manures through pipes to fertilize the sub-soil of arable land. The system was afterward enlarged and developed into a system of sub-irrigation where surface irrigation could not be practiced. It was carried to the United States and is now quite common where water is scarce, and in orchards, vineyards and for deep rooted plants generally.

SUB-IRRIGATION AND DRAINAGE COMBINED.

In every properly arranged system of irrigation the ditches or other conveyers of water are equivalent to open drains devised for the purpose of flowing water from the surface along lines and in directions carefully surveyed.

According to the common understanding, drainage means carrying off an excess of water from swamps and cold, over-moist soils for the purpose of reclaiming them, or converting them into fertile fields. But since irrigation plays so important a part in farm economy and profitable plant culture, indeed, since it has become an absolutely essential element of success in the arid and sub-humid regions of the United States, and is gaining ground in the humid regions, it has been discovered through costly experience that drainage and irrigation are inseparable systems.

Originally, the pioneer farmer on arid and semi-arid lands, finding none at all or very little water or even moisture in the sub-soil, disregarded drainage if he ever even thought of such a thing, and went on pouring water upon the soil and into it faster than it could evaporate.

The surplus accumulated little by little, until after a few years he discovered that his vines, trees and even small fruits were beginning to die at the tops. Investigation disclosed the curious fact in an arid region, that there was too much water in the soil; that a water table had formed, in some cases within two and four feet of the surface, and that no means of drainage having been provided, this water table was constantly rising, and, in the course of a very few years his land would become a valueless swamp. A ridiculous thing in a rainless region, but one that was quite common.

Again, the advent of an enormous ditch or canal was hailed with joy. It meant water, and water in the arid regions, it must be confessed, means everything. As years went on, the water in the canal was insidiously working its way through the sub-soil by infiltration or seepage and dissolving the deleterious alkalis in the soil through which it passed, carried the solution down to the low lying lands, saturated them and evaporating, left a whitened soil dead, so far as useful vegetation was concerned. Quite naturally there was much consternation, and various remedies were thought of. Beets and sorghum, and other gross feeding plans, were recommended as alkali destroyers. Then ditches were dug to carry off the seepage water from the bottom lands or to prevent further infiltration from the canals. An unconscious recognition of the necessity for drains.

Still the insidious infiltration went on, and by and by barren black or white patches began to appear higher up the sloping land, until seepage water became the bane of the irrigation farmer. Then came the idea of cementing the great ditches to prevent seepage, a good policy where water is to be transported long distances but if all ditches were cemented there would be no infiltration and many lands would revert to an arid condition and pioneering would have to begin over again. The great aim of converting arid lands into fertile, moistened soil would be defeated if seepage or infiltration were to be stopped entirely.

Out of this condition grew the idea of drainage systems which it was supposed would more or less obviate the alkali trouble, but this also deprived the land of seepage water from canals and ditches in which the water was good irrigating water, and so wasted it.

Scientists came to the rescue and gave the patent opinion that the good water became bad by associating with the deleterious elements in the soil, picking them up in solution and carrying them along down to the lower levels, and then backing up, on the principle that it is the nature of water to seek its own level, carried up the deadly ingredients to the surface, and there abandoned them in a cowardly fashion and evaporated, leaving alkali and other impurities behind to destroy vegetation, ruin fertility.

But this did not dishearten the farmer, for if one tract of land ceased to be productive by reason of an excess of alkali deposits, he selected a virgin tract out of his numerous broad acres and went on as before. But now he is confronted with the alkali fiend on all sides in certain regions and seeks a remedy against it. The demand now is for small farms, every foot of which may be made productive, and be more profitable than a large ranch cultivated in patches.

Years, nay, ages ago, in other arid regions than those of the United States, the same difficulties encountered by the western irrigation farmer were experienced and sought to be overcome by means of drainage. It was soon discovered that by drainage alone, the vegetating stratum above the drain pipes no longer presented its natural cohesion, but dried and cracked into fissures to such an extent that surface irrigating water cut gullies into the soil through which it rapidly disappeared on its way to the drains to be wasted or to obstruct the drain pipes. These inconveniences were grave in the case of small irrigating ditches, but were aggravated when the main supply ditch or canal crossed the line of drains. A remedy was sought by giving the drains a steeper incline to create a strong, rapid current through the pipes, or by using light conduits with vertical wells or tubing at certain fixed points, up which the excess water might rise and thus regulate the flow, or again by isolating the drains and the irrigating ditches.

In drained fields two experiments were tried:

First. The drains were buried only about four inches below the turf, and the surplus water allowed

to spread out through open joints of the tiles, or through openings expressly made for the purpose, within reach of the roots, whereas, in drainage exclusively, the drains operated contrariwise by drawing the water away from the roots. By this method none of the land was overlooked and irrigation could be effected at any time, and liquid fertilizers could be introduced whenever desirable. The pipes were easily laid in an ordinary furrow opened by a plow, and could be multiplied economically to any extent.

Second. The second process was to lay a certain number of drains along the line of the steepest grade and connect them with a transverse collecting pipe or conduit, in the center of which was arranged a vertical tube or well of wood or tile, up which the water ascended and flowed over into a main ditch from which the surface could be irrigated in the usual manner. Each transverse collecting drain corresponded with a principal flowing ditch, and to suspend irrigation all that was necessary was to throw open the front or end of each discharge drain where it entered the transverse collecting drain.

The vertical tubes or wells were vent holes provided with sluices which could be worked from the top in any desired convenient manner, whenever it was desired to drain without irrigation or irrigate without draining, or whether it was desired to hold the water at a given level in the soil to furnish seepage water or irrigate by infiltration.

The principle of these methods is identical with that of ordinary irrigation, which, after all is said, is the seepage or filtration of water from above down through the soil, and the absorption by the soil of the elements held in suspension or solution by the water. Carbonic acid is disengaged by flowing over the surface, is partially decomposed by the plants and absorbed by them, and the remainder passes into the soil. Oxygen, after subjecting what it reaches to the phenomena of combustion, which explains the fertilizing effects of irrigation, is less abundant in water filtered through the soil than in that which flows over the surface, while, on the contrary, carbonic and sulphuric acids increase in quantity. By seepage or infiltration from below upward, mineral matters, lime, chalk, potash, etc., are not precipitated mechanically, but deposited in the sub-soil unless the water be saturated, which is too often the case in the alkali lands, but which is more or less obviated by combining this system of drainage with irrigation. At all events it reduces the quantity of the deposit of deleterious mineral salts to a minimum. In addition to that desideratum it is possible to wash the alkali out of the soil by permitting the saturated water to drain off and carry with it the alkali in the sub-soil or near the surface, top washing of course carrying the surface alkali down within reach of the drains. It is like cleansing a sponge of its impurities. Dip an impure sponge in a basin of pure water and squeeze. The water becomes impregnated with the impurities of the sponge. Throw away that water and fill the basin with clear water and dip in it the sponge and squeeze as before. By and by the water running from the sponge is clear, showing that the latter contains no more impurities.

If it be true, as the majority of the scientists maintain, that the use of irrigating water is all the more beneficial when vegetation is most flourishing and luxuriant, and that the nutritive elements in the soil are directly absorbed by the roots, it is apparent that the oxydizing and purifying action of drainage combined with irrigation must be the means of supplying vegetation with the necessary plant food, either through the infiltration of the water into the region of the roots or by intermittent flowing over the surface from the vent wells.

The system is quite simple, expense alone being probably the only disadvantage, but even then, if the land must be drained, the laying of tiles, if with a view of also irrigating, will divide the expense.

By an arrangement of valves or plugs managed from the vertical vent wells, the pipes are closed at the point where irrigation is desired. Then, the water flowing through the drains is stopped at the closed valve, escapes through the loose joints of the tiles, and if permitted, will make its way to the surface. When one section has been sufficiently irrigated in this manner, the valve is opened, and another one further down is closed, and the soil in that section irrigated in the same manner. To drain without irrigating, all the underground valves are opened and the water flows through the secondary drains into the main, or transverse collecting drain, to be carried off entirely or into a reservoir for further use unless too alkaline.

To wash the soil, repeat the process of irrigation and drainage several times successively until tests show a weak solution.

This system of irrigation and drainage may be adapted to any condition of soil, or to any topography. Indeed, the principle of the siphon may be connected with it. Regard, of course, must be had to the nature of the plants to be irrigated when it comes to regulating the depth at which the tiles are to be placed, or the height to which the water is to be permitted to ascend in the soil. Where the land is flat the tiles may be laid on a light grade, the source of the water supply above the tiles regulating the velocity of the current of water and the height to which it can be raised in the soil. In such cases, a fifty or a hundred-acre tract may be subirrigated by infiltration until it is in a fit condition to cultivate for any crop without any flowing over the surface. In sloping land the pipes should be laid parallel with the slope to insure uniformity of distribution, at, say, four feet below the surface for ordinary culture, with transverse collecting pipes at intervals, so as to lay out the land in sections, each one of which may be irrigated in turn. Practically, the system means the creation of an artificial water table managed at will.

A query arises here: Will not the water rising in an upper section of land through the drain pipes also descend to the section below at the same time in obedience to the law of gravity?

The answer is that water as such certainly will descend and much faster than it rises. But moisture will not. In irrigating the upper section of a tract of land through drain pipes, the water is under pressure which overcomes gravity. Again, the soil will absorb the water as fast as it rises and not until it is saturated will it give any of it up, and then the surplus will begin to flow downward, but when that moment arrives the irrigator opens the valve and removes the pressure, suffers the saturated land to drain off and moisture alone is left, which, as has been said, does not drain downward, but ascends toward the surface in obedience to the law of capillary attraction.

SURFACE, SUB-IRRIGATION AND DRAINAGE COMBINED.

It is possible to combine surface, sub-irrigation and drainage by the same system of underground conduits

or tiles, and for that reason drainage should always be arranged with a view of making a treble use of it.

The line of irrigation is always along the line of drainage, which is evident from the fact that drainage is nothing more than disposing of the excess water that flows through the soil. There is no other way for it to reach the drain tiles except through the soil, and this is true whether the soil is arid or a swamp. The flow of irrigation water is necessarily in the same direction as the drainage water, and hence it is economy to combine them.

If the water source is high enough above the field to be irrigated or drained, a sufficiently large reservoir or retaining ditch should be provided. From this, what may be called the "velocity water," is to be supplied. That is, the water naturally flowing downward toward the drain pipes can not rise to the surface except by seepage or infiltration, and then only when the lower drain courses are closed at their intersection with the transverse collecting drain. But water let in from an elevated source, unites with the drainage water and forces it to the surface or to any desired height, even above the surface if necessary or required.

Now, by closing the exits of the drain tiles at any point, the water may be forced up through the vertical vent wells or tubes and allowed to flow into distributing ditches through which any part of the land may be surface irrigated, and a double use of the drainage system be effected. It is a convenient and profitable mode of irrigating small, shallow rooted plants, strawberries, for instance, and the tubers like potatoes that will not stand water soaking. Likewise it is adapted to the kitchen garden and floriculture.

It is an admirable system for what is termed "winter irrigation," where the water supply is more abundant in the winter months than in the dry season. Sub-irrigation is practiced to fill the soil with moisture, and then by storing the water, surface irrigation becomes practicable when planting time arrives, and when plants show their first true leaves. By that time their roots are in moist soil and they grow to maturity with very little after irrigation unless shallow rooted.

There are three classes or conditions of atmosphere or meteorological conditions existing in the great west, however, which should be understood whenever mention is made of "winter."

In the arid and semi-arid regions of the south and southwest, and on the Pacific slope where the Kuro Siwa or Japanese ocean current creates a perpetual spring climate, what is known as winter is the growing period for cereals and garden products. In these localities the seasons are commonly divided into "wet season" and "dry season," winter as it is known elsewhere being unknown. If there be any rainfall at all, it usually begins in October or November and ends in April. Sometimes the rainfall for the season ranges from four inches to ten, sometimes reaching fourteen inches, the latter quantity being sufficient to raise a fair crop of grain without irrigation, but in the case of corn and vegetables constant cultivation is required.

In these regions winter irrigation is beneficial for deciduous plants, which overcome their winter sleep and spring into life in March or April, small fruits, orchards and the like, for it fills the soil with moisture at a greater depth than the rainfall can reach, and when a trifle of surface irrigation is added, they grow and produce profitably.

In the absolutely arid regions where there is an absence of rain, or less than five inches, frequently assuming the form of what is known as a "Scotch mist," nothing can be grown in the way of profitable plants without irrigation of some kind. Now, if the sub-soil can be charged with moisture it will be retained for a long period if the surface soil be kept open and highly pulverized to serve as a mulch, and with a little irrigation it will perform wonders of plant growth. Moreover, by constant infiltration, an artificial water table will finally be created which will become perpetual with periodical additions. In irrigation there is always more water put into the soil than is necessary for plant growth, and the excess water, allowing for evaporation, must flow down into the subterranean receptacles. If there be a sloping field above, then it will perform the duty of a storage reservoir for the lower one, and the escaping water may be caught and utilized as has been already described.

The second climatic condition to be observed, is where the region is cold and frosty in winter, but without much snow or other precipitated moisture. Here, winter sub-irrigation prepares the soil for spring cultivation, and sufficient water is retained for surface irrigation when needed to enable plants to start. Colorado and western Kansas, with portions of western Nebraska and eastern Wyoming, are illustrations.

The third condition is where the snows of winter are very heavy, equal to the rainfall in humid regions, but the summers are dry. Northern Utah, Montana, Idaho, Nevada and the Dakotas may be placed in this category. In such regions, winter irrigation and drainage go together naturally. The soil is aerated, maintained in a friable, tillable condition, and almost as soon as spring opens plowing and planting may begin. The soil is charged with water which, if excessive, must be drained off, and if insufficient, the drainage pipes are closed and a uniform saturation induced.

(*Chapter XV will be concluded in August issue.*)

It would almost seem that Providence has had a hand in fitting Hon. F. W. Mondell for the duties of a representative in the lower house of the National Congress.

He is distinctly a man of the people.

He came up from the ranks.

He made his own way and is as much of the people today as he was when he "struck out" for himself a young and energetic boy only a few years ago.

His association, employment and experience for years have made him a many sided man.

He understands mining conditions from long contact with mining men and actual experience in developing the famous Cambria coal and coke district.

He knows what it is to work with his hands as well as his mind.

He knows ranch, farm, irrigation and public land problems as few other men in Wyoming know them.

As a "pioneer" in Newcastle, its first mayor, a State Senator and member of Congress four terms he has had a legislative experience that admirably equips him for the onerous duties of representing a State of such diversified interests.

As a speaker he has few superiors and his resume of Republican history and Republican principles at Laramie on accepting the nomination for a fifth term in Congress would serve as a fine party platform should not another line be written. *Wyoming Tribune.*

BROUGHT BY THE POSTMAN.

Artesia, N. M., June 11, 1904.

The D. H. Anderson Publishing Co., Chicago, Ill.

Gentlemen: Yours of May 30th at hand. I will endeavor to send you some data concerning artesian wells. If not on the subject of well measurement, will give you a few facts concerning the advantage of artesian wells for irrigation. I shall try to send the report in a week or so. Will you be able to reproduce a picture from a picture of the well, or should I send a wooden plate of the well? We have some magnificent wells in this section.

Yours respectfully,

S. W. Gilbert.

Chicago, Ill., June 15, 1904.

Mr. S. W. Gilbert, Artesia, N. M.

Dear Sir: Replying to your favor of the 11th in which you express a willingness to send us data concerning artesian wells, would say that we will appreciate your kindness in the matter and hope you may get it on to us in time for our July issue, which will go to press on the 5th of that month. If not, we will use it in our August issue.

Kindly send the wooden plate you have and also photograph of any wells you may care to have us illustrate and we will select from same cuts to accompany the article.

The D. H. Anderson Publishing Co.,

Montgomery City, Mo., June, 1904.

The Irrigation Age, *Chicago, Ill.*

Gentlemen: Enclosed you will find 10 cents in stamps for which please send us a single copy of The Irrigation Age with subscription rates and to pay for your answer to the following questions, if you be so kind as to answer them:

1. Between what dates should wheat be sown in the Arkansas Valley?
2. Does corn grow successfully in the Arkansas Valley? What is about the average yield per acre?
3. What are Arkansas Valley farmers paying experienced irrigators and general farm hands working by the month?
4. Which crop of alfalfa is usually cut for seed in central New Mexico and when does it ripen?
5. Which is cut for seed in Wyoming and when does it ripen?
6. Which crop is cut for seed in the Arkansas Valley and at Fort Collins, and when is it cut?
7. What is a fair yield per acre of seed in Colorado?
8. What price is paid per cwt. for it?
9. Is hog raising a success in the Arkansas Valley?

Hoping you will answer the above questions and send us a copy of your paper, we remain,

Fuhr Bros.,
R. D. No. 2.

The inquiry received from Fuhr Bros. was referred to Philo K. Blinn, Field Agent of the Agricultural Experiment Station of Colorado, who sends us the following reply:

Rocky Ford, Colo., June 23, 1904.

Irrigation Age, 112 *Dearborn St., Chicago, Ill.*

Dear Sirs: In answer to the enclosed questions referred to me, I will submit the following as far as my experience goes:

1. For fall wheat, September 15 to October 15; spring grain, March 1 to April 15 and possibly May 1.
2. Corn grows successfully, but is not considered a standard crop. Nights are too cool for good corn, yet it is not uncommon for corn to yield forty to sixty bushels per acre on good ground.
3. Hands on farms are paid twenty-five to thirty dollars per month and board. The latter price for experienced men in Colorado farming.
4. Do not know.
5. Do not know.
6. Usually the second crop, but sometimes the first if it blooms satisfactorily. Same at Fort Collins usually, but in September, depending on season.
7. From two to eight bushels per acre; four or five a fair yield.
8. Price varies from 5 to 12 cents, 6 to 8 cents per pound.
9. Hog raising is in a measure a success; pastured on alfalfa. a cheap growth and in fall, cantaloupes, beets and grain finish up a fair product.

Philo K. Blinn.

IRRIGATION MARVELS.

Austin, Texas, May 28.—Archer Richardson, the pioneer irrigator of Dimmitt County, was here today from his Oakgrove ranch near Carrizo Springs. He comes from the section where irrigation is just proving to do such wonders, the onion crop having been a small gold mine. Richardson's accounts of irrigation in Dimmitt are simply marvelous. He says he has two artesian wells, 215 yards apart, 650 feet deep, which water 1,000 acres and grow the finest crops to be seen anywhere. Onions, cotton, cabbage, corn, Irish potatoes, peaches, strawberries, dewberries and blackberries. He says he is now securing the second crop of strawberries and the most luscious fruit to be found.

The cotton makes two bales to the acre, but is planted only the first year to get the land ready for the truck and fruit. He says the returns from the latter are from $300 to $400 per acre, and that tobasco pepper can be grown there to yield $1,800 to the acre.

Figuring on onions he says 32,000 pounds to the acre are easily grown, which at 2 cents per pound, bring net over cost of cultivation, about $600, or $384,000 for one section of 640 acres. Richardson states that about four thousand acres were in irrigation in Dimmitt County last year, though it is forty miles from a railroad, and that great gangs of Mexicans are now grubbing new land for next year, receiving $6.25 per acre for the work. He says the price is to be increased in order to get more land ready for irrigation next year.

He says the irrigated peaches are large and finer flavored than those of Maryland and Georgia, and other products the same. He says the great returns from irrigation in Dimmitt are due to rich soil, unceasing sunshine and an abundance of good pure artesian water.

Mr. Richardson is at the head of several large land owners negotiating for a railroad to Carrizo Springs, but did not care to make public any of the particulars, only saying that at this time there are easily an average of sixty cars per day for 300 days in the year, of truck, etc., not to mention cattle and wool, and with the ever increasing acreage in irrigation the tonnage would double.

He says the coming of a railroad will make Dimmitt County one of the best in the State and would develop a great industry.

"ONLY LIVE FISH SWIM UPSTREAM."

Salt Lake City, Utah, June 14, 1904.

Great excitement prevailed on Main street today, and many conjectures, pertinent and otherwise, were hazarded by the crowd which clustered about a gentleman of generous proportions, who stood upon the curb holding in his hand a large wriggling fish of the Redhorse variety. Vociferous laughter greeted the amazement with which each newcomer became enlightened as to the why and wherefore of this unusual spectacle. It was evident that a catch had been made under exceptional conditions.

The writer did not learn what disposition was made of the find, but it is to be hoped that it appeared upon some hospitable board that evening, and was served up with all due honors.

From Utah Lake, where fish abound, to this newly discovered resort for anglers on Main street, is a distance of over thirty miles. The highway upon which the adventurous truant of the deep must have followed is the Utah Lake Canal, which winds for miles along the base of the Wasatch Range, eventually feeding the ditch in question, among many others.

In view of the undoubted veracity of the gentleman above mentioned. as well as existing circumstances which refute any other theory, it became the generally accepted opinion that the plucky member of the finny tribe had bidden farewell to the placid waters of Utah Lake, triumphantly passed the dangerous currents of the canal, and having at last reached the most congested portion of the city (with what purpose is unknown), he had turned upon his course and was about to retrace his steps (if the word can be used), when his doughty career was brought to an untimely end.

Had the fish been dead when found, his arrival in our midst would have left little room for speculation. He was however, very much alive, and was, at the time, struggling bravely against the current in an uphill effort to pass the shallow gutter, with a pertinacity which bore witness to many perils successfully overcome in the past. By this time, it is to be expected that the veteran is no more, and it seems fitting that the obituary should appear in The Irrigation Age, which still holds to its motto, that "Only Live Fish Swim Upstream."

E. W. H.

THE ROSEBUD INDIAN RESERVATION.

382,000 Acres of Fertile and Well Watered Lands Open to Settlement.

Some two years ago the Chicago & North-Western railway built the Verdigre and Bonesteel line to the eastern border of the Rosebud Indian Reservation, thus securing the only direct line from Chicago, Minneapolis, St. Paul, Sioux City, Omaha and other points in the West to the fertile region which is now to be thrown open to settlement under the United States Homestead laws.

Under President Roosevelt's proclamation United States Registry Land Offices are to be opened July 5th at Yankton, Fairfax and Bonesteel, S. D., for the registration of applicants for these lands. The registration books will remain open until July 23d, and commencing July 28th, drawings will take place, to determine the order in which the applicants will be permitted to make final entry and settlement. The final entry begins at Bonesteel, August 8th. No one is permitted to register or make entry to land by mail, but must be personally present at one of the three points named for registration and at Bonesteel for final entry.

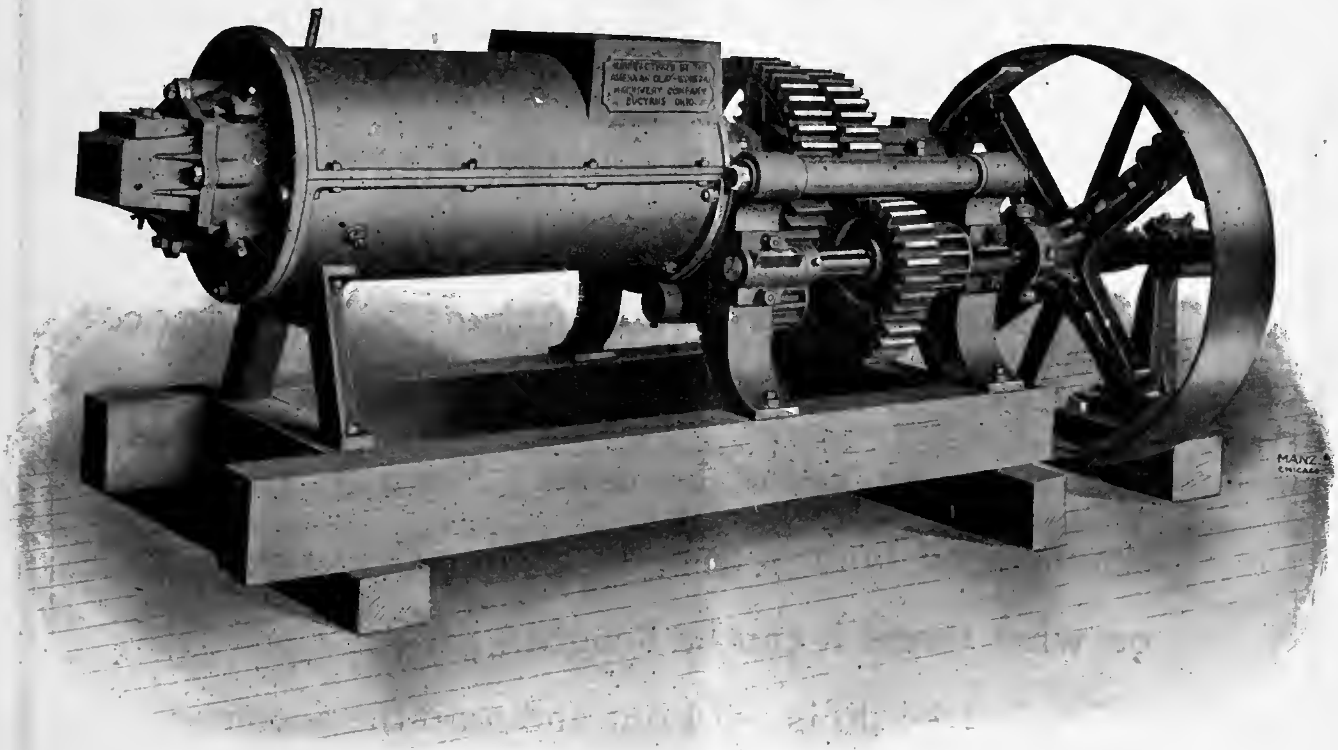
The lands are well watered by the Missouri, Niobrara and White Rivers and are remarkably fertile, situated in the midst of the great corn belt of the Missouri Valley, where similar land is worth from $20 to $50 an acre. With an altitude of about 2,200 feet, they are in a region which can not be excelled for healthfulness.

A heavy influx of people is looked for at these points of registration, and everything possible is being done by the North-Western line to spread broadcast all information in the shape of maps and folders that is of interest to applicants for these lands.

The Temple Pump Company, Chicago, Ill., advertise in our columns their famous gasoline engine, "The Master Workman." It costs less and is less expensive to run than other engines is the claim of the manufacturers. It has two cylinders and weighs less than half the weight of one-cylinder engines, so can be mounted on any light wagon. It has no vibration. It can be adapted to more uses than other engines. This firm was established in Chicago in 1852.

A SOUTH DAKOTA WHEAT FIELD.

HOMESEEKERS IN ROSELAND COUNTY—TRAIN LOAD OF EXCURSIONISTS AT BONESTEEL.



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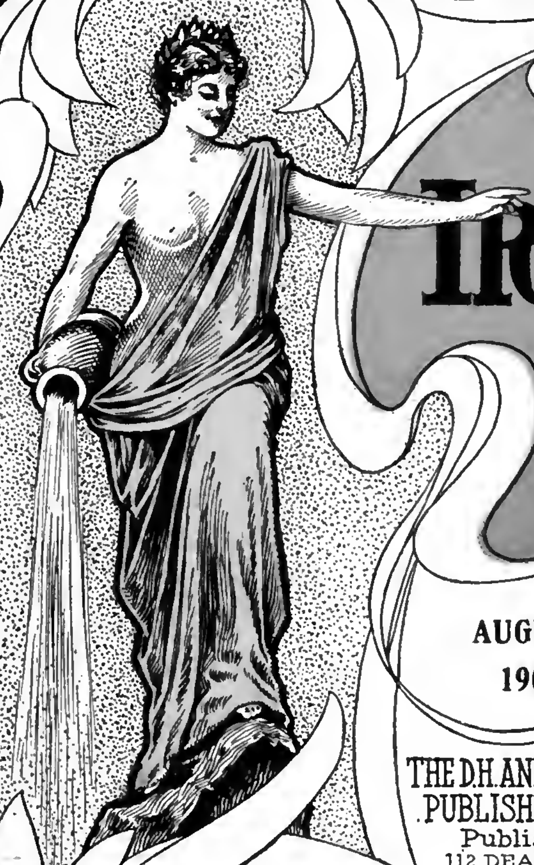

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ESTABLISHED 1879

SPECIAL FEATURES

CHARLES A. COX CHGO.


The Samson
The Windmill That Makes
Irrigation Possible Anywhere
"Blow high or blow low," The Samson is always ready. Made of galvanized steel throughout, it is strong and durable. The wings are so shaped and so set on the arms that they utilize more of the force of the winds than any other mill made.
THE SAMSON
is a double-geared mill and the strain is between the gear wheels and the lift is in line with the center of the power exerted. The strain is evenly divided among four bearings instead of one, as in single-geared mills. This arrangement saves wear, side draft and the twisting strain that comes with the use of single gearing. The double gear insures steadiness in operating and prevents the wobbling that shakes and weakens the tower.
The Samson is the latest and most perfect production of the largest windmill factory on earth and is the result of experiments without number and the experience of many years spent in building windmills.
The Samson is self-oiling, the extra large oil-cups needing to be filled only at long intervals. It is strong enough to stand up and work in the highest wind, and is so carefully made that it catches and utilizes a very light breeze. For irrigation purposes, no windmill ever made will do the same work that the Samson will. It lifts water from the deepest wells with perfect ease, and will pump more hours in a year than any other windmill ever made.
We have not space here to tell all about this mill. We publish the best and finest booklet ever sent out from any windmill factory and will be glad to send it to you on request. It describes every piece and illustrates the minutest details. All this is told in an interesting manner, and when you have read the booklet, you will know all there is to know about the Samson. It is not necessary to cover up or gloss over any point. We are proud of it to the smallest bolt for in every detail it stands for windmill perfection. Send for this booklet to-day.
Stover Mfg. Co.,
617 River Street,
FREEPORT, ILL.

THE IRRIGATION AGE

VOL. XIX — CHICAGO, AUGUST, 1904. — NO. 10

THE IRRIGATION AGE

With which is Merged

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

El Paso Convention Hall. The executive committee of the Southwestern Irrigation Association at its last meeting awarded the contract for the construction of a convention hall capable of seating more than 3,000 delegates, who will arrive there in November to attend the annual session of the National Irrigation Congress.

The building is to be completed by October 1st, after which it will be decorated and furnished in readiness for the convention.

Senator Hansbrough. Hon. Henry C. Hansbrough, the senior senator from North Dakota, is what the world calls a practical man. His knowledge of the Western country has well fitted him for the distinction which he enjoys as chairman of the committee on public lands. Besides being a pioneer resident of the Northwestern frontier, Senator Hansbrough has been an extensive traveler. For some years he was a citizen of California, where he first began the study of irrigation. Away back in the '80s, years before statehood was established in North Dakota, Senator Hansbrough began advocating irrigation for all the semi-arid parts of the country. In his first campaign for Congress he enhanced his popularity with North Dakota people by an intelligent discussion of the land laws, the irrigation problem, etc. North Dakota is thoroughly educated on the subject of artificial irrigation. The people believe in the principle and they keenly realize the need of its application. If they have been slow to act it is not through the indifference or neglect of their public men. The few artesian wells now in existence are the result, to a great extent, of the persistent and earnest advocacy of Senator Hansbrough. Many years ago he presented facts showing how easily that part of the frontier could be irrigated from the lakes, rivers and vast subterranean reservoirs. Senator Hansbrough has had an exceedingly interesting career. He is not a showy man, but nevertheless is one of the most capable party leaders in North Dakota. His various political battles have shown great shrewdness on his part. The fact that he is now serving his third term in the United States Senate proves that he has a strong hold upon his people. It is everywhere admitted that he is one of the most useful men that the Northwest has ever sent to Congress. His intimate knowledge of the land laws and the needs of the agricultural class is fully appreciated by his colleagues in the Senate, who also esteem him for his sterling character and good, practical sense. The senator has always been a working journalist. A little less than thirty years ago he was doing newspaper work in Chicago, and it is almost a quarter of a century since he located in Dakota Territory.

Irrigation Congress. By recent advices from El Paso we learn that preparations for the 12th National Irrigation Congress, to be held in that city November 15-18, are well under way and the citizens of the gateway of the southwest anticipate a large attendance. The press committee has informed us that Mr. James Charlton, of the Transcontinental Passenger Association, has given notice to the officers of the Congress of extremely low rates offered by the lines under his jurisdiction for the benefit of those desiring to attend the Congress. The rate of one fare for the round trip is offered by all lines west of the Mississippi River with an extension of thirty days. Mr. T. J. Anderson, general passenger agent of the G. H. & S. A. Ry., who represents the association in the Southwest, has fixed the dates of sale for these tickets at November 10, 11 and 12. In addition to this concession from the western roads, the irrigation association has also obtained unusually low rates from the Mexican and territorial railways, not only for the benefit of visitors, but also for those wishing to take side trips to Mexico or other points of interest during or immediately after the convention.

A movement is on foot to bring fifty or a hundred Apache Indians from the Mescalero reservation of New Mexico to El Paso during the Congress. These Indians, it is stated, will be permitted to hold the scalp dance for the edification of visitors and it is presumed will show the bloodthirsty savage in his wildest moods. Old Geronimo, the famous Apache chief, will also visit El Paso, if permission from the Government may be obtained, for him to meet the remnants of his tribe during their sojourn in that city. The citizens of El Paso are to be commended on their effort to offer adequate entertainment to all who may attend and it is sincerely hoped that this Congress at El Paso may equal in point of attendance the record breaker of Ogden in 1903.

The Irrigation Age is in receipt of information indicating that a lot of the old time workers along irrigation lines will not attend the El Paso Congress, owing to the fact that the Maxwell-Boothe crowd are attempting to run it for their own glory and profit. It is the impression of The Age, however, that all workers for the cause should attend and lend such assistance to the citizens of El Paso and the southwest as will make this one of the best meetings ever held. It is, of course, unfortunate that such men as those above mentioned are in a position to mislead the people of El Paso, but this is no reason why the rank and file of old irrigation workers should withhold their support, and it is to be hoped that those who have decided to pull away from the Congress may reconsider and lend all the aid in their power to furthering the general cause of irrigation.

We are informed that the hotels will be able to offer ample accommodations to all who attend and everything will be done in the way of side trips and entertainment which the visitors could reasonably expect, so that all who go, whether for the business of irrigation or pleasure, will find entertainment and profitable diversion.

$15,000 Entertainment Fund. The executive committee of the Southwestern Irrigation Association has compiled a statement showing that fifteen thousand dollars will be spent in entertaining the National Irrigation Congress in November.

Calls the "N. I. A." a Fake. Apropos of the trouble brewing among members of the National Irrigation Association and the proposed investigation of that body by men whose names have been used as officers and backers without their full knowledge of its plans, the following editorial from the San Francisco *Chronicle* is extremely interesting at this time. The *Chronicle* is the leading daily newspaper of the Pacific coast and is owned by M. H. De Young, one of the wealthiest and most influential men in California, and the utterances of his paper always mean something.

C. B. Boothe, chairman of the board of directors of the National Irrigation Association, took exception to the term "Fake Association," which the *Chronicle* had applied to that body. Boothe refers to a long list of names of distinguished gentlemen bulletined as officers of the association and asks if it is possible to suppose that such men would lend their names to a fake association. The *Chronicle* replies that it does not believe that the gentlemen referred to would lend their names to what they believed to be a fake association, but is of the opinion "that most of them permitted their names to be used without knowing much about the origin, history or methods of the concern." The *Chronicle* then says:

"The board of directors, for example, of which Mr. Boothe is the chairman, consists of twenty-four business men, mostly of national reputation. The *Chronicle* has grave reasons to doubt whether those gentlemen ever met as a board of directors, unless, *pro forma,* a few of them have got together at some annual meeting. We are sure they take no part in the management of the concern, for we are sure they would never have authorized some things which have been done in the name of the association. The same may be said of the bewildering array of vice-presidents and other officers. It is also to be said that a good many of the officials have always been also prominent railroad officials and from their standpoint the institution is quite the reverse of a fake association. As they look at it, it is perfectly genuine."

The *Chronicle* then gives the following facts, which, in its opinion, justify the term "Fake Association" as applied to the so-called National Irrigation Association and make it a proper object of suspicion:

"The association purports to be an outgrowth of popular sentiment crystallized into an association representing, and authorized to represent, a large body of people interested in irrigation. As a matter of fact, the organization of the association grew out of the proposal of one person looking for remunerative employment, made to the president of several transcontinental railroads, and involving an appropriation of $6,000 a year from each of them. That appropriation was the sole support of the concern until other contributions were

obtained in small amounts from many individuals, and the railroads, as the largest and only absolutely reliable contributors, have always been able to control. There was, of course, no impropriety in the railroads contributing to educate the Eastern public in regard to irrigation, and in so far as they have interests distinct from the public they are entitled to a hearing, but when their contributions and control and the real origin of the association were kept profound secrets, and the concern paraded as a genuine public association, the *Chronicle* submits that nobody has reason to complain if it is called a fake association. The secrecy which has always maintained as to the railroad control is ground for reasonable belief that there were ulterior objects in view opposed to the public interests. This was much strengthened in the minds of those who knew the facts by the character of the person in real control of the institution, for he was one who had done California infinite injury by beginning and conducting through the press a most virulent war on the Wright law and all bonds issued under it, declaring that not a single bond issued under it was valid, the attack being made while he was counsel for an irrigation district which was seeking to avoid payment for its bonds, and apparently for the purpose of terrifying bondholders into a surrender of their claims for some nominal amount. This course greatly injured the financial credit of California communities, and when a person of that kind was found directing a so-called association created and organized as this was, and soliciting the names of prominent men to give it standing by accepting nominal offices carrying neither duties nor control, there was evidently a concern which would bear watching."

The *Chronicle* gives the association credit for creating an interest in irrigation and says that money was spent freely and wisely to that end, but adds:

"With the published policies of the association the *Chronicle* has usually agreed. Of its ulterior objects we are ignorant, but few will believe that if there were no ulterior and unpublished objects there would have been any secrecy in the source of the income. The intense hostility to the association, however, which has developed in many sections of the West is not so much due to fear of improper gains to the railroads from the use of an apparently public association to promote private ends as from the overbearing, dictatorial manner of its only active officer, and his relentless persecution, in the name of the association, of every official whom he can not control. At the last session of the California Legislature telegrams from this person assumed to absolutely dictate for what purposes money should be and should not be appropriated, and they were evidently taken by some legislators as orders to be implicitly obeyed. It was the familiar crack of the whip of the railroad boss, directing the railroad gang. These telegrams could not be obtained for publication, but they were shown to men present in Sacramento, promoting a public measure in the public interest, to convince them that they were up against the real thing and might as well surrender, which they did.

"It is tactics of this kind which are at the bottom of the ugly feeling with which this alleged "association" has come to be regarded, and there is evidence which is conclusive, in our judgment, that the baneful influence of the concern is quite as effective in some departments of the National Government as in State legislation. If the National Irrigation Association will abandon the pretense of representing a popular movement and come out into the open as the agent of corporate interests it will be entitled to recognition and hearing as such."

This scathing arraignment of the National Irrigation Association is an unqualified indorsement of the position taken by THE IRRIGATION AGE in this matter. We have always claimed that the National Irrigation Association was not conducted for an honest purpose, but was used as a powerful grafting machine for the benefit of one individual. Now that the eyes of the estimable gentlemen whose names have been misused in connection with its officers have been opened it is not likely that the National Irrigation Association will ever have any further influence in the legitimate irrigation movement of this country.

PRESIDENT ROOSEVELT CALLS A HALT.

So rank had become the interior department's policy in segregating public lands for forest reserves that Mr. Roosevelt was finally called upon to stop the practice and did so the other day by issuing an order requiring all such matters to be referred to the interested senators and congressmen before withdrawing land from entry. This curtails the power of the interior department and means a better administration of such affairs. In Gunnison County one-third of its area was lately withdrawn from settlement and the same deadfall fell upon Routt County while petitions galore were presented asking for the enlargement of the Battlement mesa and Uncompahgre reservations. This looks like adding insult to injury when we consider that in the former there exists a plateau sixty miles square upon which no tree grows and only sagebrush abounds. A few years ago some cute cattlemen about the size of Ed Wetzel saw to the preparation of these lines and it looks like inconsistency to see them fighting the reserve policy now. It is after all like the tariff outrage—merely a local question and the proposition to shut out the settlers at this time should create no especial disturbance in the cow camps, although the whole thing becomes quite as farcical as one of Grover Cleveland's historical messages to congress on the silver issue.—*Denver Field and Farm.*

THE GOVERNMENT PROJECT IN UTAH.

E. W. HART.

With the completion of the San Pedro railroad to the west in sight, the great Moffat line to the east, and the extensive local improvements by the Oregon Short Line under way, which bring into view the probable acquisition of a new grand union depot in the near future. Salt Lake City is forging rapidly to the front. True to the earliest policy of the Utah'ns, they have not suffered the irrigation problem to lag at this time. Indeed, one of the grandest irrigation projects ever undertaken in the West is not only afoot, but so far advanced that it is hoped that the work of construction will be able to proceed at no distant date. This immense system of water supply is designed to embrace the possibilities of Utah Lake and Strawberry Valley as reservoirs, swelled by the surplus waters of the Duchesne River, and to the north Bear Lake and the Bear and Blackfoot Rivers. This plan for unifying the available supply has been carefully worked out in detail, and is said to demonstrate the perfect feasibility of furnishing permanent and abundant water to Cache, Salt Lake and Utah Valleys in northern Utah, and to a portion of southern Idaho. When local agricultural requirements have been met by the disposal of this unfailing body of water, the growing demands of Salt Lake City will be satisfied by the diversion of the cold mountain streams which have hitherto found their way to the outlying farms.

The Utah irrigation programme has repeatedly changed form and grown into mammoth proportions since the State Commission took up the work of preparing its scheme for submission to the Government. There are still many points to be settled and much remains indefinite, but the work of survey and measurement and the organization of water users is proceeding rapidly, the project is already conceded to be practicable, and no doubt is expressed that the success of the undertaking is assured. The original plan comprised only the formation of the Utah Lake reservoir, the preliminary work upon which was done last summer, but in February State Engineer A. F. Doremus. submitted to the Government the ambitious scheme now in preparation, whereby the original plan is supplemented by a general system for conserving the flood waters of the rivers of the three valleys above mentioned, annexing the Strawberry Valley reservoir, and bringing in Bear Lake and its tributaries and reservoirs to conserve the winter and flood waters of the Blackfoot in Idaho and their transmission southward, altogether designed to afford an abundance of water at all seasons to Cache, Salt Lake and Utah Valleys, and bringing to the highest state of cultivation 1,000,000 acres of land.

Only about one-third of the available area of the three valleys is at present imperfectly irrigated. It is estimated that 1,000,000 acres can be richly cultivated under the new system, and that the average increase in the value of land will be at least $30.00 an acre, or $30.-000,000. The present density of population in this region is one person to each 1¾ acres of irrigated land, and 1,000,000 acres under cultivation will easily support 1,000,000 people.

The plan first projected by the State Commissioners contemplated no more than the improvement of Utah Lake as a reservoir, involving only some method of curtailing the loss by evaporation from the surface of the lake, especially the eastern and southern arms, which at present exist merely as extensive and unwholesome swamps. That the measures designed for this purpose are important is readily understood when it is known that of the 431,000 acre feet flowing into the lake each year, 398,000 acre feet have been lost annually by evaporation. In order to reduce the area of the lake the plan recommended by Prof. G. L. Swendsen is to cut down the channel of the Jordan River and extend it out into the lake, thus drawing the water down much below its present level. This will necessitate pumping to the high line canals, but would result in an enormous saving of water. The other plan under consideration is to run drainage ditches through the centers of the low water and swamp lands comprising the eastern and southern arms of the lake. By this method, it is also pointed out, that hundreds of thousands of acres of the richest land in the valley could be reclaimed. A still further extension of soil and further recession of the surface water could be accomplished by putting pumping dredges to work near these shores, and filling in thousands of additional acres

The plan now adopted proposes to augment the supply afforded by Utah Lake by bringing water from the east of the mountains. Strawberry Valley is in the Uinta Indian reservation and lies just east of the crest of the Wasatch Mountains at an elevation of 7,500 feet above sea level. It has an area of 7,000 acres and forms a natural reservoir, requiring only the building of a dyke fifty or one hundred feet high at one end to serve the purpose. It is proposed that this reservoir shall be supplied by a diversion channel thirty to fifty miles long, intercepting the head waters of the nearest tributaries of the Duchesne River. To deliver this water into the valley west of the range means running a water tunnel three and one-half miles through the solid wall of the mountain crest, probably the most difficult engineering undertaking involved in the entire work. The water thus brought through the mountain wall will be carried down through the channel of the Spanish Fork River to about the 4,800 foot contour, and from thence a canal will branch off southwest toward the town of Goshen and a second main channel will run northerly along about the 4,800 foot contour to connect with a main channel from the north, thus distributing water to all the high lands east of the valley. The Weber, Ogden and Provo Rivers will be dammed, like many others, all together constituting a general design to store and save the flood waters throughout the entire watershed, with branches and laterals penetrating every locality. Whether any of the water reaches Utah Lake through the Spanish Fork or not is immaterial, nor will it alter conditions there even if all its tributaries are cut off and spread over the surface of the land before reaching it, for the seepage finding its way into Utah Lake from the constantly watered high lands will more than compensate for its loss in other directions.

An objection to the idea of building expensive works, including the three-mile tunnel through the mountains, in order to deliver the water from Strawberry Valley down into the Spanish Fork River, as designed, instead of using the water in Strawberry Valley itself, is well answered by reference to the fact that in the last named valley, whose altitude is 7,500 feet, nothing can be grown except hay and grasses, while the land intended to be supplied thereby can be

made to yield, in some instances, as high as $1,200 an acre. The immense superiority of the plan is, therefore, evident at once.

Passing northward a distance of about 200 miles, we come to Bear Lake and its tributary streams. The northern end of Bear Lake is a useless swamp, known as Mud Lake. By the use of canals intercepting the streams emptying into this swamp and conducting the water to Bear Lake proper instead, together with a drainage canal intersecting the same, new soil will be reclaimed and the efficiency of Bear Lake as a reservoir will be improved.

Separated from the Bear Lake region by a divide, the basins and valley of the Blackfoot branch of the Snake River in south Idaho, at an elevation of 6,100 feet above sea level, will be utilized for impounding the winter and flood waters of the Blackfoot River, and a channel run a distance of twelve or fifteen miles over the divide, whereby such water will be discharged into the Bear River near Soda Springs, Idaho. A canal thirty miles in length will intersect the Bear River below this point, and, skirting the western edge of Caché Valley along about the 4,800 foot contour, will furnish water to a large area of land in its vicinity. Issuing from Bear River canon, between Caché and Salt Lake valleys, a large canal will extend in a southerly direction along the 4,500 foot contour, connecting at a suitable point with the main channel, already described as issuing from Spanish Fork canon and directed northward.

The cost of this great work is roughly estimated at about $5,000,000. The United States Government stands ready to devote the necessary sum of money to this project, as presented to the Reclamation Service, as soon as the practicability of the system in detail has been mathematically demonstrated by the engineers now engaged in that campaign, and the present water users and canal companies have themselves acceded to the plan in the manner required. A water users' association is being formed to carry out the latter measure, and it is with this body of representative men alone that the negotiations can be carried on by the Government. Their pledge will be required for the repayment of the $5,000,000, and the entire enterprise, when put in motion, will fall under their supervision, superseding the separate canal companies now in the field.

The water users' association will have an arduous task before it in order to gain a basis upon which to deal with the Government, for the support of the canal companies and water users must be won, their old rights and privileges abandoned for the new and their undertaking secured for the repayment of the loan. The farmer, however, is assured of a safe investment, for he pays only when the water is delivered, and that in sufficient quantity to meet all demands. The sum advanced is to be repaid in ten annual installments, without interest, and is secured by the lien of the water users' certificate upon his land. Such old canals as may prove available under the new scheme will be bought of the old companies, but in any event the rights and property of former owners will, of couse, be respected and due compensation is promised to those which must be abandoned in order to come into the new system.

The canal companies, it has been authoritatively stated, will be compelled to take common ground with the water users, and make over their powers to the association, with whom the Government will deal when their organization has been completed. It is not clear, at this time, upon what basis individual water users will be assessed for the repayment of the Government loan. Those using the water at greater distances from the main channels, or reservoirs, it is said, will be taxed more than those near at hand, the ratio being in proportion to the expense of the intervening work of construction.

An incident of this mammoth project concerns the permanent preservation of the Great Salt Lake, as well as saving vast quantities of water lost to the State through evaporation from its surface. In this regard it is suggested that the area of that lake may be readily reduced to two-thirds of its present size by making use of existing conditions. At this time the lake is intersected by what is known as the Lucin cutoff, the railroad embankment of the Southern Pacific, which cuts off about the northern third of the area of the lake. If proper alterations can be made upon the Lucin cutoff, this third can be entirely isolated and left to dry up. The water then all finding its way through the ground and through rivers to the remaining two-thirds, the latter will be indefinitely well supplied and evaporation diminished in the same proportion.

In short, the scheme comprises not only the acquisition of millions of acre feet of water now going to waste and its proper distribution and use, but also the concentration of the underflow and the contraction of the surface area of evaporation.

It is true that this great system of irrigation of the high lands will, in the course of time, necessitate the introduction of a co-extensive system of drainage for those on the lower level, but the great benefits accruing justify the expense, and it is not believed that any legal barrier could be raised by the lower users, even if so disposed, which would be sustained by the courts.

One of the remarkable benefits which would follow in the wake of the institution of this system of irrigation would be the development of enormous water power in the 3,000 foot fall from Strawberry Valley and from the Blackfoot basin into Bear River. This power would be appropriated by the water users the same as the agricultural properties of the water, for it has been announced that no corporation can legally be entitled to become a shareholder in the organization. Power plants could be erected at suitable points by the association and electricity transmitted to the water users for the operation of their machinery and farm implements.

Arriving at this stage of the propaganda, one may be pardoned for lapsing into visionary predictions of the future, when the most distant farms will be connected by electric tram cars with markets and factories, and when the only thing lacking to make the "Promised Land" a vertiable Utopia will be the advent of passenger cars in which madame, the farmer's wife, may visit town arrayed in all the splendor and finery of an alderman's wife without the fear of ruining her best gowns, which has heretofore imposed upon her the indignity of making the dusty journey in her oldest calicos and least perishable wearing apparel.

IRRIGATION DEVELOPMENT IN THE UNITED STATES, PRESENT AND PROSPECTIVE.

BY FRANK W. MONDELL.
Chairman of the House Irrigation Committee.

The national irrigation act, which became a law on June 17, 1902, and which appropriates the receipts from the sale and disposal of the public lands in sixteen western states and territories to the construction of works for the irrigation of arid lands, has very properly been characterized as the most important legislation for the development of the great West since the passage of the Homestead Act. Under wise administration, which happily seems assured, there is every prospect that the reasonable hopes and expectations of the friends of the measure will be realized, and that in the course of a very few years a considerable acreage will be added annually to our cultivated area through the medium of this law, without expense to the tax payers of the country, the original outlay being provided for by land sales in the territory to be benefited and ultimately repaid by those who shall establish homes on the lands irrigated.

HON. FRANK W. MONDELL
Congressman from Wyoming.

The moneys paid in by the settlers, are, under the provisions of the law, to be used again for the reclamation of other lands, and thus a revolving fund is created and the work of reclamation is to be carried on until the limit of available water supply for enterprises of sufficient magnitude to invite Government undertakings under the measure shall have been exhausted.

The field of operations of the law has an area of over thirteen hundred thousand square miles. The acreage which may ultimately be brought under cultivation through this agency, while largely a matter of conjecture at this time, will certainly run well into the tens of millions of acres. The works which will be undertaken will undoubtedly, many of them, rank among the largest and most important hydraulic works of the world. The communities created will in time contain millions of souls; and lands and regions now arid and almost valueless and uninhabited will teem with a dense population under the highly satisfactory social and industrial conditions which obtain through the intense cultivation of small farms under irrigation. In view of these facts, it is not strange that the law should be considered one of the most important that has ever been written upon the statute books of the nation.

Important and far-reaching as the national irrigation law is, however, and helpful and beneficial as its operation will be in providing homes for a large number of people, it should be remembered that the law by no means marked the beginning of irrigation development in the United States; nor was it intended or expected to occupy fully the field of activity which, up to the time of its passage, had been exclusively occupied and developed by individual, co-operative and corporate enterprise.

At the time of the passage of the irrigation law, we had an irrigated area in the arid region of the United States of approximately eight million acres, a larger area than that artificially watered in any other country except British India; and while no lands have as yet been watered and in all probability no considerable acreage will be for the next two years under national projects, yet irrigation reclamation by private enterprise has not been retarded by the passage of the act, but on the other hand, as was anticipated, seems to have received an impetus therefrom. The census bureau estimates that approximately 9,200,000 acres were under irrigation in July of this year. This is an increase since the irrigation season of 1899 as reported in the census of 1900 of 1,660,455 acres, an increase which, if continued, will double our irrigated area of 1900, by means of private enterprise, in thirteen years.

In the main the lands irrigated by private enterprise and individual effort have been those offering the most attractive opportunities, by reason of low cost of the undertaking per acre irrigated and favorable conditions of climate, soil and market. There have been some notable exceptions to the general rule of low cost and comparatively limited acreage under a single enterprise where the conditions have been exceptionally favorable; and as time passes, more ambitious and extensive projects for the irrigation of considerable areas

are being investigated and undertaken by co-operative associations and corporations. The field is so vast that there need be no conflict between private and public works; the Government naturally looking generally to enterprises of greater magnitude than those which invite private capital, or those presenting complications more easily solved by public undertakings than by enterprise under private control.

The larger proportion of our present irrigated area consists of lands entered by settlers under the desert land law, who in addition to the expense of reclamation have paid $1.25 an acre for their lands, which before reclamation were arid and practically valueless. In the fiscal year ending June 30, 1903, final entry was made on 264,533 acres under the desert land act; and while this entire acreage was not fully irrigated at the time of making final proof, as the law only compels the irrigation of a portion of each forty-acre tract at that time, and in many instances the topography of the lands entered prevent the reclamation of the entire tract, unquestionably the major portion of our increased irrigated area for the year is of lands irrigated under the provisions of the desert land act. The importance of this reclamation under the desert land act is increased by the fact that a very considerable proportion of the lands thus irrigated consists of comparatively small tracts in isolated localities, which become the nuclei of a mixed farming and stock growing business, assuring the most advantageous utilization of the surrounding non-irrigable grazing territory.

Under the desert land donation act, commonly called the Carey Act, which was passed in 1894, a very considerable area has been irrigated and settled in small farms in a number of States; most satisfactory progress under this law having been made in Wyoming, where about 65,000 acres have been thus reclaimed, with several projects for the irrigation of considerable tracts under way. This law, particularly where supplemented by wise State legislation, has all the safeguards of the national irrigation law to insure home making on small tracts, and has made possible the development of larger areas and more expensive projects than could ordinarily be undertaken by individuals or associations operating under other land laws.

In addition to the irrigation of public land under these laws, development is constantly going on for the reclamation of lands already in private ownership, including, in the Southwest, lands included in Spanish and Mexican grants. The opportunities for the irrigation of small areas by the impounding of flood waters in reservoirs whose cost is within the means of the average farmer are almost unlimited in the arid region; and as the demand for agricultural products and the search for lands upon which to found homes increases, while the knowledge of the practice and value of irrigation becomes more general, the utilization of these opportunities will be constant and in the aggregate the lands thus reclaimed will constitute a very considerable as well as a most valuable portion of the irrigated domain of the country.

So numerous are the opportunities which careful research and investigation will present for large and expensive works, costing from hundreds of thousands to tens of millions of dollars, for the irrigation of from thousands to hundreds of thousands of acres, that for some time at least the disposition will undoubtedly be to pay most attention to, and make the major portion of the expenditures, under the national irrigation law, on enterprises of considerable magnitude; though unquestionably enterprises for the irrigation of comparatively limited areas will be undertaken, and in many instances such are at the present time the most earnestly urged and would undoubtedly be of the greatest immediate benefit, not only in furnishing opportunities for home building, but also in testing all features of the national irrigation law. With the utmost activity in extending work under the national law, there will remain abundant opportunities for the investment of private capital in works which will insure fair returns on the investment and be of great benefit in providing homes under the favorable and agreeable conditions which surround agricultural pursuits in irrigated regions.

Except for the fact that the Government expects no profit on its enterprises under the national irrigation law, but provides water for the irrigation of lands at the actual cost of the construction of works, there is no essential difference between the methods of the Government under the national irrigation law and judicious irrigation undertakings by private enterprise. The Government proceeds to the irrigation of its lands exactly as any wise and careful landowner might do, and on the completion of the works, the titles to individual water rights are maintained and protected as in the case of lands irrigated by individuals or private organizations.

There is at this time in the national irrigation fund, available for construction under the national law, about $16,000,000. The reclamation service of the geological survey having charge of the work under the law, has made examinations of projects in all of the States and territories to which the bill is applicable. Two projects are already under construction, one in Nevada and another in Arizona, and enough projects have already been examined which will probably prove to be feasible to consume, together with the projects already undertaken, all of the funds now available. The beginning of construction on some of these enterprises will quite likely be delayed for some time yet, by reason of the necessity of further surveys and examinations, and construction on each project will necessarily extend over a considerable period of time, during which, if the proceeds of the sales of the public lands do not fall below normal by reason of radical repeal or amendment of land laws or periods of depression and low prices of farm products, which always curtail the demand for public lands, the fund will be annually reinforced by from two to four millions of dollars. In all probability the annual proceeds from the sales of public lands available for work under the national law will never again reach the large sum available for the last fiscal year.

The practical workings of the national irrigation law in all of its features will not be fully tested for a number of years to come; not until considerable areas of public lands are watered and settled and paid for under the provisions of the act can we have practical demonstration of the wisdom of all of its provisions; but it is a matter of gratification to those who had to do with the framing and passage of the act, as it must be to all American citizens interested in the development and growth of their country, to know that, so far as the work has proceeded, the law appears to be wisely drawn to meet all conditions, elastic enough to provide for the development of projects of widely differing character, and yet sufficiently guarded to be safe.

THE SCOPE AND PURPOSE OF THE IRRIGATION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

BY ELWOOD MEAD, IRRIGATION EXPERT IN CHARGE.
Courtesy U. S. Department of Agriculture.

(Continued.)

IRRIGATION IN THE HUMID PORTIONS OF THE UNITED STATES.

The experience thus far gained makes it certain that irrigation is destined to be an important means of improving the already prosperous conditions of agriculture in humid and subhumid portions of the United States. The possibilities along this line have not yet been fully established, but the lessons thus far learned seem to be that it has a wide field of usefulness wherever intensive agriculture is practiced or where insurance from drouth is important. The irrigation investigations of this office now include a study of the problems of irrigation in this region, in Wisconsin and Missouri, to determine what can be done in the States of the middle West; in New Jersey, to ascertain its field of usefulness in the North Atlantic States; in the Carolinas and Georgia, to determine its possibilities in the South Atlantic region, and in Louisiana and Texas in connection with the increasing use of irrigation in the production of rice.

IRRIGATION IN THE MIDDLE WEST.

During the past season studies of the benefits of irrigation in Wisconsin have been carried on under the immediate direction of Prof. F. H. King, of the College of Agriculture of the University of Wisconsin, at the station farm at Madison and at Stevens Point. In both cases the water supply had to be provided by pumping, and records have been kept to show the amount of water used, the time of its application, the cost of pumping and the increase in yield of the various crops to which it was applied. Owing to the exceptional drouth which pervailed the results were highly favorable to irrigation. The difference in the yield and size between the irrigated and unirrigated potatoes is shown graphically in the illustration (Plate XL), in which the larger piles of larger potatoes represent the product of the irrigated rows and the smaller piles of smaller potatoes the unirrigated rows. If the results of one season's trial would justify drawing definite conclusions, it would be that irrigation in Wisconsin is a marked success; but that is not the case, and it is the intention to continue these studies for a number of years, the work being broadened so as to include all the crops which promise beneficial results.

A co-operative investigation in irrigation is also being carried on between the Missouri Experiment Station and this office at Columbia, Mo., under the direction of Prof. H. J. Waters. Applies, strawberries and nursery stock were the crops receiving the most attention, arrangements for the water supply not having been completed in time to prepare for its application to other staple farm crops. The beneficial effects of the irrigation of strawberries are shown in the illustration of the irrigated and unirrigated rows (Plate XLI, Fig. 1 and Fig. 2). Careful records were kept of the quantity of water used, the cost of furnishing it and the time of its application. The report of Professor Waters states that "the season was very disastrous to strawberry plants, many of the old plants dying and practically no runners being formed under ordinary treatment. The irrigated plants developed strong crowns and undoubtedly stored an abundant supply of food for next year's crop. The strawberry nurseryman, the man whose business it is to supply plants for the commercial strawberry grower, will find in irrigation absolute protection against failure." It will require next year's record of the yield to determine the

Showing growth of strawberry patch on the unirrigated plat at the close of the season.

full measure of the benefits of this year's irrigation. Referring to the result of this year's watering of nursery stock, Professor Waters believes that nurserymen will find irrigation exceedingly profitable, that it will result in securing larger growth in young trees, trees with better formed heads and possibly a saving of one year in the time when nursery stock can be placed on the market. He also believes that the protection of bearing trees from injury by drouth is a matter of very great importance, because this injury often extends beyond the season when the scarcity of water begins.

IRRIGATION IN THE NORTH ATLANTIC STATES.

In the North Atlantic States the large area devoted to market gardens makes security against drouth a matter of much importance. Throughout this region the average rainfall provides sufficient moisture if properly distributed, but short drouths just at the time when the crops are maturing frequently cause heavy losses. In many years no such drouths occur, but they come often enough to make the growing of vegetables and small fruits uncertain. The problem to be solved is whether the saving of an occasional crop and the increased yield of many crops will repay with a profit the cost of providing a water supply. The study of these questions is being carried on by this office in connection with the Agricultural Experiment Station in New Jersey, Prof. E. B. Voorhees, director of this station, being in charge. His experiments, so far reported, have been limited to small fruits. They show that, in case of almost all varieties, the increase in the product of the irrigated tracts over the unirrigated ones was considerably more than enough to pay in a single season the entire cost of providing the water supply, as well as the expense of applying it.

In addition to making experiments with small fruits Professor Voorhees collected data from private parties in regard to the irrigation of various kinds of garden truck. In most cases the results were equal to those obtained in the experiments made under his personal direction, paying the entire cost of installing the pumping plants, with a profit, in a single season.

An analysis of the rainfall records at Philadelphia, covering a period of seventy years, shows that in considerably more than half the years there was a lack of rainfall in some one month of the growing season to seriously affect the yield of small fruits and garden vegetables, which constitute so large a part of the products of the Eastern farms. Taking Philadelphia records as typical of the Eastern United States, and the results so far obtained in New Jersey as a basis for deduction, it will be seen that an irrigation plant would be a profitable investment for most of the farmers living where our large cities provide a ready market for small fruits and vegetables.

It is not likely that the water-right problems which are so large a factor in Western development will prove of equal importance in the East, owing to the larger flow of streams and the fact that the areas to be irrigated will always be restricted, but in many localities there are already indications that important legal problems will have to be solved before irrigation can safely assume the importance which its value wiill naturally give it. The work of this investigation along the legal and social lines can well be extended to this section. The experience of the West will in time come to be of value in solving the water problems of the East.

Scene Wisconsin Experiment Station No. 2.

Among the important work which needs to be done in the East along agricultural and engineering lines is a study of the cost of installing and operating pumping plants for small areas. Something has alredy been done along this line and arrangements are being made to continue this more effectively in the future.

RICE IRRIGATION.

During the past season the problems of rice irrigation have received much attention from this office. The investigations inaugurated have been principally along agricultural and engineering lines. In the Carolinas it has included a study of the methods of storing water to provide a supplemental water supply; the

methods of diverting and distributing it over the fields and the problems connected with the regulation of tidal rivers so as to determine what may be done, either by the Government or by the concerted action of private individuals, and the construction and maintenance of levees for the protection of fields against floods or injury from breaks above or below.

Rice growing in the Carolinas and Georgia is not as important an industry as it was fifty years ago. In part this decline is due to the cost of labor. The rice fields are located along the low, alluvial bottom lands, where the greater part of the work must be done by hand. This leaves only a small margin of profit at present prices, and the danger of this being occasionally lost through breaks in levees or river floods has tended to retard a revival of what was once an important and valuable industry.

There seem to be two or three questions which this investigation can properly deal with. One is to what extent State or Government aid is required to assist in the regulation of streams, and to study the topography and watersheds of streams to ascertain what measures may be taken to furnish a supplemental water supply through storage.

The growing of rice on the uplands in Louisiana and Texas presents an entirely different condition of affairs. Here the industry has been from the first unusually successful, and it has increased until it has assumed a national importance, promising to make the United States an exporter instead of an importer of this staple product.

Aside from the agricultural questions peculiar to rice farming, the irrigation of these uplands presents new problems in canal construction and the lifting of water. In the arid region streams as a rule have a heavy fall, and it is, therefore, easy to get water onto the lands to be irrigated by gravity. In the rice districts the water supply is below the lands to be served, in streams which have hardly enough fall to produce a perceptible current, and the water must, therefore, be raised by pumps. Even with this expense, rice growing has proven remarkably profitable. The rice lands, which were formerly worth from $1 to $3 per acre and used only for grazing, now sell for from $30 to $50 per acre and yield an annual return equal to the value of the land. About 250,000 acres of these lands have already been devoted to rice culture, and much more is capable of the same use.

Along a few of the streams used more land has already been devoted to rice than the streams can properly water, and the question of protecting the early users against the demands of those coming later is pressing for settlement. Louisiana has no laws or customs affording this protection. The publications of this office place at the command of the canal owners and lawmakers of that State the results of the experience of other States and countries, and will afford them the means of enacting a just and intelligent law governing water rights whenever such action becomes necessary.

A report will soon be published showing the methods used in irrigating rice and discussing the problems which have arisen in the rice districts. This investigation should be continued by the experts employed by this office, whose familiarity with conditions elsewhere makes them especially fitted for the solution of the problems arising in this new field.

CANTALOUPE SEED.

Improvement by Selection.

BY PHILO K. BLINN,

Of the Agricultural Experiment Station of the Agricultural College of Colorado.

The cantaloupe now known as the Rocky Ford was originally Burpee's Netted Gem, but under the favorable conditions which prevail in the arid regions of Colorado it has developed into a melon surpassing in quality the parent stock, and its superior merits have won for it a new name and a popular reputation.

In the early days of the cantaloupe industry at Rocky Ford the growers relied on Eastern seedsmen for their supply of seed, and to a certain extent had satisfactory results, unitl the growth of the industry exceeded the supply of reliable seed, when a number of growers were supplied with seed which produced a

PLATE I.

mixed lot of varieties, wholly unfit for market as Rocky Ford cantaloupes. The loss not only fell heavily on the disappointed grower, but through the agency of bees and other insects carrying the pollen the injury was easily transmitted to neighboring fields of choice melons, producing crosses of an undesirable nature.

On account of the introduction of these mixed strains and the varying ideas of seed selection, the Rocky Ford cantaloupe lacks uniformity in many respects. A large percentage of melons are unmarketable on account of size and form, which render them unfit to crate. Defective netting and thin, soft flesh are also common imperfections. Because of these defects the growers sustain a loss that could largely be prevented by planting a better grade of seed.

The cantaloupe is a product of years of systematic selection, and it requires the same methods to maintain its excellence as were employed in its development. Without care in selection, the natural tendency of all cultivated plants to vary will soon cause a good strain of cantaloupes to revert to an undesirable type.

There is a marked contrast between the products of carelessly selected and pedigreed, i. e., carefully selected, melon seed; the one is inclined to be irregular in size and form, with the netting thin and often wanting, and with a decided tendency to ripen prematurely, turning yellow and soft, a loss not uncommonly of 20 to 40 per cent in culls, while choice seed produces melons that are uniform in size and shape, the netting thick and complete, the marketable stage more prolonged and practically no loss in culls.

PLATE III.

PLATE IV.

The wide reputation of the Rocky Ford cantaloupe has created a great demand for Rocky Ford seed, as it is claimed to produce a higher grade of cantaloupes than seed from other States, and each year large quantities are saved to fill this demand, but, unfortunately for the industry, the quality of this supply is not what it should be. It is principally produced from the cull piles.

After frost, at the close of the shipping season, everything in the line of a cantaloupe, green or ripe, large or small, is gathered and run through a melon-seeder with no attempt at selection.

This seed is bought by the jobber and seedsman for 10 to 20 cents per pound, and when it is on the market it can not be distinguished from well-selected seed, and doubtless is sold as such.

There would be nothing to commend such seed to any practical grower if he realized its source.

As the seed market has been so abused, to procure good seed one must either save it himself or have seen

the melons from which it was saved, or purchase it from a reliable grower before it has passed through several hands.

The fact that seed can be had cheap and growers are willing to plant it is an evident reason for its existence on the market, but the lack of information as to what constitutes a good seed cantaloupe may also be responsible for poor seed selection. In this bulletin we wish to show what a good melon is and that it pays to plant and save good seed.

STANDARD OF PERFECTION.

The form and outward appearance of a perfect Rocky Ford cantaloupe is well represented in the several plates shown in this bulletin; as to size, it requires a melon slightly over four inches in diameter and about four and five-eighths inches long; it should have silver gray netting that stands out like thick, heavy lace, practically covering the entire melon, save the well-defined slate-colored stripes; these should run the whole length of the melon, clear cut as if grooved out with a round chisel, and terminating at the blossom end in a small button, well shown in the melon on the left side of Plate III. The interstices in the netting should be light olive green, that turns slightly yellow when the melon is ready for market. A melon with a black skin under the netting it not so attractive in appearance. The proper netting is well brought out in Plate I.

But the outward appearance is not the only basis for selection in saving seed. The inside points are as essential to consider as any external quality, and no one can determine that a melon is fit for seed until it has been cut open and the inside qualities examined. For this reason the machine seeder is of no use in selecting choice seed. The melons should all be cut and examined by hand.

The flesh should be thick and firm, of a smooth texture and free from watery appearance, rich and melting in flavor. The shipping and keeping qualities depend largely on the solidity of the melon, so the seed cavity should be small and perfectly filled with seed. The color of the flesh near the rind should be dark green, shading lighter toward the seed cavity, which should be salmon or orange in color. The flesh is often mottled with salmon and not uncommonly the entire flesh is of that color. The flavor is usually quite uniform, though it is sometimes affected by the health of the vines or other conditions of growth.

The seed will bear close inspection, as it is sometimes cracked or sprouted, which renders it of no value for germination.

The first steps in seed selection should be made when the melons are growing. Extra prolific hills should be marked with stakes and the earliest ripening specimens conforming to the above ideal should be saved as choice seed and planted in a place isolated from other melons, and the same care should be exercised in the years that follow.

The grower can and should save his own seed, as he can give it more careful attention than any commercial seed grower.

A few growers, realizing the importance of systematic selection, have made the proper choice of seed for their own use.

As an illustration of what can be done in this line the plates shown in this bulletin represent photographs of melons developed after five years of careful seed selection. Beginning with a melon as nearly perfect as could be found, the old saying that "like produces like" has been exemplified to a marked degree. Each year the number of perfect melons has increased, so that now, when soil, fertility and all growing conditions are favorable, the oversized melons are eliminated, all melons are completely netted and practically all are marketable.

Plates II and IV represent an average product of the choicest of this seed.

Improvement is still possible, yet the value of careful seed selection has been so demonstrated that if melon growers would only adhere to a strict selection of perfect, early-ripening melons, not only would the returns from the melon crop be increased, but the cantaloupe would become a more staple article by virtue of its improved shipping and keeping qualities.

VALUE OF CHOICE SEED.

Unless one has a well-developed strain of seed it is not probable that he can save more than one or two pounds per acre of extra selected seed, so the supply of choice seed is limited.

The market value of the cantaloupe at the time the seed is saved should determine the price of seed. Thus it requires about as many melons to produce one pound of seed as will fill a standard crate, and actually more, because some melons need to be rejected. This can not be fully determined until the melon is cut, when if it proves unfit for seed it is also lost for market. So the price of seed must be equal to or exceed the price of a crate of melons at the time the seed was saved.

During the first week or ten days of the shipping season at Rocky Ford it is common to realize from $2 to $6 per crate. No one at this time can afford to save seed to sell at the ordinary price per pound. Indeed, few growers are wise enough to save for their own use.

At the average price of cantaloupes through the shipping season, the grower must realize at least $1 per pound to warrant him in saving seed for the market. At the close of the shipping season, when melons are no longer marketable, the seed is willingly saved for what it will bring. This is the source of a large part of the seed on the market.

The difference in value between seed saved early from perfect melons of high market worth and that saved six weeks later from immature, frost-bitten melons, which can not be marketed, is not often appreciated; yet if the higher priced seed should yield only one or more crates per acre of early melons, or increase the total yield by several crates, which the extra vitality and superior points of perfection can easily do, the higher priced seed is cheaper at any price, and its value to the melon industry can not be estimated.

IRRIGATION EXPERIMENTS IN ARIZONA.

Investigations Covering a Period of Four Years at the Experiment Station Farm at Tucson.

BY PROF. ALFRED J. M'CLATCHIE,
Agriculturist and Horticulturist of the Arizona Agricultural Experiment Station.

(Continued.)

ORCHARDS.

Since it is important that trees be properly irrigated from the first, it will be well to begin the discussion of orchard irrigation with the setting of the trees. During the first year all varieties of fruit trees, whether deciduous or citrus, need to be treated in about the same manner.

Fig. 4. Irrigating young strawberries through shallow furrows.

Before the trees are set furrows are run near the lines of the tree rows for the early irrigations. Usually water is run through the furrows before the trees are set, and as soon thereafter as practicable. The furrows should be cultivated up within a month, and fresh ones made for each subsequent irrigation. The young orchard should be irrigated only along the tree rows, and the soil should be kept moist to a depth of several feet. This will induce the trees to send their roots down deeply, instead of out laterally near the surface. Deep irrigation followed by deep cultivation will prevent the growth of roots near the surface. Since much depends upon the treatment of the orchard during its early growth, it pays to give the trees special attention the first season.

As the trees get older they will need less frequent irrigation during the growing period, and more of the water may be applied during winter. After they are four or five years old, at least three-fourths of the water needed may be applied to deciduous trees during January, February and March. The remainder needed may be applied when water is most abundant during summer. The furrows do not need to be cultivated up after each winter irrigation; but they should be renewed as often as once a month, if a green manuring crop is not grown in the orchard. Such a crop is an excellent check to the flow of the irrigating water, as well as a benefit otherwise. When the winter irrigation is finished the soil should be thoroughly cultivated to a depth of eight to twelve inches, and the surface be permitted to remain dry until the time of the summer rains.

Where the soil is of the proper character the tree roots penetrate to great depths, enabling them to thrive though the surface stratum be quite dry. In the station orchards their roots are abundant at a depth of twelve to sixteen feet, and many of them penetrate to a depth of more than twenty feet. This characteristic makes it possible to store in the soil during winter much, if not all, of the water needed to produce a good crop. To one orchard at the station farm all of the water used by the trees during the past three seasons has been applied from December to March, while the trees were dormant above the surface. That they were not dormant beneath the surface was shown by an examination made February 20, 1900, revealing that, at a depth of ten to sixteen feet even, young roots three to six inches longs had already grown.

As demonstrated by experiments reported on in bulletin No. 37, a deciduous orchard may be kept in excellent condition and will produce good crops of fruit if irrigated during the winter only. In fact, the results from the winter-irrigated orchard were better than from the same orchard irrigated during earlier years through the summer, and better than from other similar summer-irrigated orchards the same seasons.

Aside from the difference in the results obtained, and the amount of labor involved, it should be taken into consideration that the water available during the winter has a much less value, upon account of its comparative abundance, than the water available during the summer. Even if a greater amount were used by the winter-irrigating plant it would still be the cheaper method.

Citrus orchards, upon account of being evergreen, need somewhat different treatment than do deciduous orchards. In deep soils a large part of the water they

need during the year may be applied during the winter, as recommended for deciduous orchards. But they commonly need more water during the summer than do the latter. However, it does not seem to be wise to give citrus trees sufficient water during summer to keep up a fresh growth during the hottest weather of July and August, and from October 15th to December 15th water should be withheld entirely. Fresh growth made during the middle of summer is apt to be injured by heat, and growth made during the late fall is apt to be injured by cold. The best time to induce unprotected citrus trees to make growth seems to be from March to June inclusive.

PEAS.

If sown from November 15 to February 15 peas may be planted just as they are in regions where they are not irrigated, and furrows for irrigation made after the peas have made some growth. To make this possible the soil in which they are to be sown should be thoroughly irrigated and well plowed and harrowed previous to sowing. As long as they are making a thrifty growth it is best to withhold water.

If sown at other times of the year than the season mentioned above, it will usually be necessary to sow the peas along previously-made furrows, or to make furrows directly after they are sown. Running water through these furrows is usually necessary to bring the peas up during the warm weather of early fall and early spring. In whatever way or at whatever time they are sown it is best not to keep the soil too wet and to cultivate it after each irrigation.

POTATOES.

At least half of the water necessary to produce a spring crop of potatoes may be stored in the soil before the field is planted. If two-thirds to one foot of water (the amount necessary depending on the condition of the soil) be applied and the soil plowed deeply and well harrowed just before planting, potatoes may be planted here during winter in just the same manner as they are in regions where they are not irrigated, the field harrowed level, and no further attention be given them for about two months. If weeds appear, or if rain occurs, however, it is best to harrow the field once or more during these two months.

The best time to plant in this region is usually early February, and the plants should appear about a month later. If the soil has been put into proper condition previous to planting, potatoes will usually produce a better crop if not irrigated until early in April. For irrigation, make furrows midway between the rows (which should be thirty to thirty-six inches apart) with a good-sized shovel plow. Turn a small stream of water down each furrow and permit it to run four to eight hours, the time depending upon the character of the soil. The applications of about 0.4 of a foot of water at each irrigation is advisable. As soon as the soil is sufficiently dry, which will be in two to three days, the field should be thoroughly cultivated. During the remainder of April and during early May the crop will commonly need either one or two more irrigations. After giving the last irrigation, instead of using a cultivator, when the soil is sufficiently dry, the shovel-plow used for furrowing may be run in the furrows and the soil thus thrown about the plants.

Fig. 3. Irrigating young strawberries through endless ditches.

If planted during August for a fall crop, instead of harrowing the field level after planting, as is done in the winter, the furrows made in covering the potatoes need to be left for the first irrigation, which must usually occur soon after planting. The subsequent treatment is the same as of winter-planted potatoes, except that the crop will need more frequent irrigation. But usually, though irrigated freely, a satisfactory crop can not be secured at this season.

The winter-planted crop of potatoes, since it makes the most of its growth during cool weather, is produced with a comparatively small amount of water—less than in some cooler regions, where potatoes are necessarily grown during the summer. A total of 1.5 to 2.0 feet of water is ample to produce a good crop in most soils. The tendency with many growers is to apply too much water and to give too little cultivation. The amount of water mentioned above, with proper cultivation, will produce a better crop than double the amount without cultivation. Too early irrigation tends

to cause too rank a growth of tops without the formation of as many tubers as if the plants were not irrigated. It is better to permit the potatoes to continue growing in the mellow soil in which they were planted, as long as they are growing thriftily, than to compact the soil by too early or too excessive irrigation. The less water the crop can be grown with and the more thoroughly it is cultivated, the better will the quality of the tubers be.

The potatoes planted January 9, 1901, as will be seen by referring to Table VI, gave a lower yield than those planted February 1st. This was due to the frequent frosts that occurred during March. Those planted earlier were larger when the frosts came and consequently sustained more injury than those planted later. On the other hand, those planted the latter part of February did not have sufficient time to make a full growth before the warm weather of May, and consequently did not give so large a yield as those from either of the other two plants. Judging from the experience of the past four years, during average years a larger yield from a given amount of water applied may be expected from potatoes planted during early February. During mild winters a heavier yield may be secured from potatoes planted about the middle of January, but during no year, according to our experience, is it wise to postpone planting much after early February, if a full return from the water applied is to be expected. The two objects to be kept in mind are the avoidance of the March frosts and the securing of the principal growth of the crop before the heat of May. The attainment of these two objects is not always easy. If planted too early or covered too lightly they are apt to be injured by frosts in March. On the other hand, if they are planted so late or covered so deeply that they are not nearly full grown by May they will not produce a satisfactory crop, no matter how much water be applied to them.

PUMPKINS AND SQUASHES.

Pumpkins, squashes and cucumbers are irrigated in the same manner as are melons. Furrows are made four to eight feet apart, water run through them and the seed planted along one side when the soil is sufficiently dry.

The only squashes cultivated generally in this region are the early bush varieties. These are planted in February and March and produce their crop before the heat of summer. The common winter squashes grown so extensively in the North are grown very little here, as they do not endure well the heat of our summers, no matter how much water is applied to their roots. Instead of these squashes is grown the Cashaw pumpkin, which does well here and keeps well through the winter. For winter use it is planted during June, and from the time of planting until fall needs frequent irrigation.

Cucumbers are planted at about the same distance and irrigated in about the same manner as muskmelons. They are planted during February and March, and from that time on need quite frequent irrigation. They do not usually produce many pickles after the heat of June. For a fall crop they may be planted during June and July, in which case they will need frequent irrigation.

SORGHUM.

The seed of sorghum is sown in the bottom of furrows during May, June and July, a light covering of earth thrown upon the seed by dragging a bush through the furrows or by turning a light furrow with a plow, and water run through the furrows soon after planting. Some growers leave these furrows permanently and run water through them every ten to fifteen days. The better way, however, usually is to cultivate up the furrows after each of the early irrigations and make fresh ones for each subsequent irrigation. After the sorghum has reached such a size that it is not convenient to furrow it, the furrows may be left for the later irrigations. By this time the sorghum will shade the furrows and they will not become hard and baked as they will before the crop covers the ground. As this crop is grown entirely during the warm weather of summer, considerable water is required to produce it, but on account of its excellent system of roots not as much water is needed as might be expected.

STRAWBERRIES.

Strawberries are irrigated in this region almost entirely through permanent furrows. The furrows are either left open at each end or they are connected at alternate ends, and an endless ditch through the patch thus formed. This method of irrigating through an endless ditch is necessary in small pieces, especially where the ground is sloping. The water is simply turned in at one side of the piece and permitted to make its way, by flowing back and forth, through the entire piece. If the strip across which the furrows extend be long, water is admitted at several places along the side, either at all places at the same time or at the different places successively. If the field be large, especially if it is long and nearly level, strawberries can be irrigated to better advantage through furrows that are open at each end. A small stream should be turned down each furrow and permitted to run long enough to wet the soil about the plants properly. If the streams are small enough, little water will escape at the lower ends of the furrows.

Whatever the method of subsequent irrigation, the procedure in setting the plants is much the same. Water is run through the furrows, the plants set along the water line a few days afterward and water again run through the furrows as soon as practicable. In the case of the endless ditch arrangement, the water run through before setting the plants usually fills the furrows about half full; hence the plants are set about midway between the bottom and the top of the ridges. Along the open furrows the plants are set near or at the edge.

For the first few weeks subsequent to the first irrigation after setting, water should be applied often enough to keep the soil about the roots constantly moist. When the plants have become established the soil about them does not need to be kept quite so moist, but should never become very dry. The frequency of irrigation necessary will depend upon the nature of the weather. During the cool weather of winter irrigation twice a month will be sufficient. During March, April and the early part of May irrigation once in eight days will ordinarily be sufficient. From the latter month until October, strawberry plants should receive water once in four days. During the remainder of the fall months once in eight to twelve days is sufficient.

The advantage of the endless ditch arrangement is the convenience of irrigation, especially upon uneven ground.

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,

Expert in Drainage and Irrigation, U. S. Department of Agriculture.

From Farmers' Bulletin No. 187, Courtesy U. S. Department of Agriculture.

(Continued.)

A pond, previously waste land, was drained at a cost of $8 per acre. It was broken and sown to millet and the first crop paid the expense of underdrainage.

A farm of 160 acres, situated in an Illinois drainage district, was taxed $5 per acre for the general outlet. It was bought for $30, subject to this tax of $5, costing the purchaser $35 an acre. Tile drainage and improvements cost $15 per acre, making the land cost $50 per acre. The farm was rented and yielded the owner a rental of $5 per acre for four successive years, or 10 per cent on the entire investment. He was then offered $80 per acre for the farm and refused it.

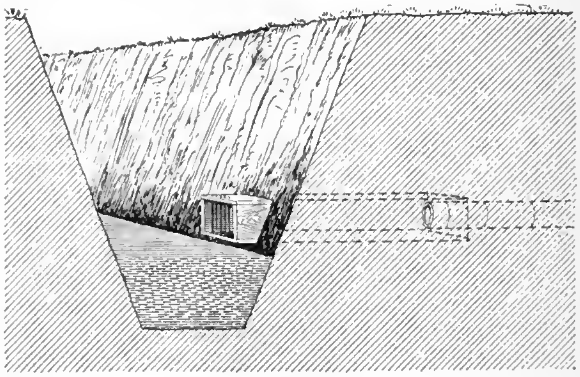

Fig. 16. Catch basin for leading surface water into a tile drain.

As will be noticed in comparing the two maps of drainage given on preceding pages, there is a material difference in the method of treatment necessitated by the differences in soil. In the Kentucky plan (Fig. 15) the drains are placed systematically fifty, sixty and seventy feet apart, the entire cost of the work being $25 per acre. The plan of the Illinois work, where the soil possesses better drainage properties, was made with special reference to the particular requirements of the land in connection with natural drainage and the work cost about $9 per acre. The drains in both plans have been in actual operation for several years and are evidently well adapted to the needs of the respective localities.

It is a well-recognized fact that no practical gardener or fruit grower attempts to practice intensive cultivation on land which is not fairly well drained, either naturally or artificially. It would be easy to multiply examples of the profits which accrue from the practice of soil drainage, not only to the farmer who drains his land and cultivates it himself, but also to the capitalist who purchases land which is comparatively worthless without drainage and then improves it in this way as an investment. What has been said, however, will be sufficient to indicate that nothing brings a surer return for the money invested than does the drainage of rich soils.

CATCH-BASINS AND PROTECTION OF OUTLETS.

Surface water should be excluded from the tile drains unless sufficient provision is made for conveying it into them in such a way that dirt, sand and rubbish will be prevented from entering. This may be done by the use of catch-basins constructed of two lengths of sewer pipe set in a vertical position (Fig. 16) and covered by an iron grating (*a*) to prevent rubbish entering the drain. This grate may be covered with a pile of bricks or small stones (*b*) to act as a coarse filter and prevent the clogging of the grate. The bricks or stones may be rearranged and the silt removed from the bottom of the basin occasionally so that with proper care such an arrangement will serve an excellent purpose for removing surface water from places where it can not pass through the soil with sufficient readiness and at the same time do no injury to the drain. Such basins should not be connected with drains of less diameter than six inches. Under the conditions which make it desirable to use them, the surface water will be received and pass away before the soil water reaches the drain.

While a substantial stone or brick bulkhead at the outlet of each main drain, when well made, has a permanent and workmanlike appearance, it is expensive and in many localities impracticable to use because of the lack of proper material. One of the most common, as well as most efficient, protections is the plank box with wire bars placed vertically across the end about two inches apart. Such a box (Fig. 17) should be made of two-inch plank, twelve feet long and large enough to admit of the insertion of the tile into the upstream end. It should be laid correctly, and more

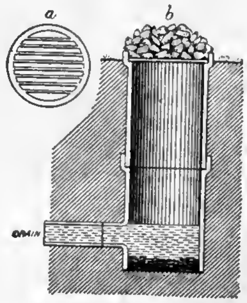

Fig. 17. Outlet protection for drains.

than ordinary care should be taken in tamping the earth securely about it. In fact, the entire filling should be well tamped from bottom to top. A protection of this kind serves two purposes: It prevents small animals from entering the drain, which they are likely to do when no water is flowing from it, and obviates the necessity of using vitrified tile at the outlet, which it is always wise to do for the reason that red tiles usually scale when exposed to the weather under such conditions.

OBSTRUCTION OF DRAINS BY ROOTS.

As far as known, the roots of grains, grasses and annual field crops do not obstruct underdrains, but this is not the case with the roots of some trees. Among them are the willow, water elm, tamarack and sometimes the soft maple, which in a short time will fill the drain with a mass of root hairs, even when they are growing fifty feet distant from the line of the drain. It should be noted that our field drains under

ordinary conditions contain no water during a considerable portion of the growing season. Those drains which are fed by springs or have a continual flow through them are more subject to obstruction from the roots of trees than drains which are dry for a part of the year. Dr. W. I. Chamberlain, of Summit County, Ohio, in writing upon this subject, says:

"I have lately dug down to my drains in an apple orchard set twenty-one years ago with trees thirty-three

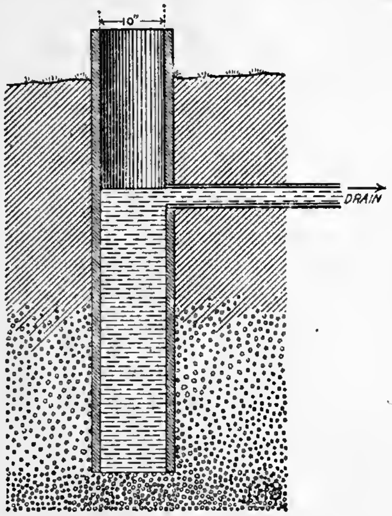

Fig. 18. Drainage of irrigated land by wells.

feet apart, and whose roots long since met and passed each other and whose branches have nearly met, and the drains placed between the rows are wholly free from any obstruction by roots."

An orchard known to the writer was set on the farm of Mr. L. Goodwin, in Tipton County, Ind., thirteen years ago, consisting of apple and pear trees in rows thirty feet apart. Tile drains were placed five feet deep between the rows and as yet are unobstructed by roots. The tiles in a small fruit garden adjoining this orchard, drained in a similar way, are still free from roots.

Where there is reason to suspect that there will be difficulty with tree roots the joints of the tiles near

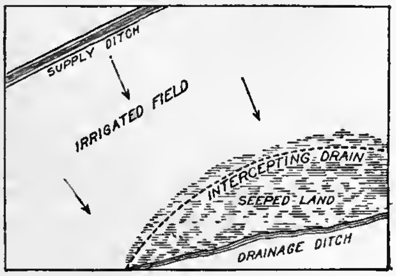

Fig. 19. Drainage of irrigated land by intercepting drains.

the trees should be securely cemented. It is safe to say that all willows and water elms growing within fifty feet of any tile drain should be destroyed, irrespective of the flow of water in the drain.

CO-OPERATION IN DRAINAGE WORK.

It is not often the case that drainage can be accomplished in any comprehensive manner without co-operation among landowners. Outlets can not always be secured upon the land which it is desired to drain. Water courses exist without reference to land lines or the desires of individual owners. The property of some owner is more elevated than that of an adjoining neighbor, and as a result the lower land, in a state of nature, receives the drainage. All land is entitled to such drainage relief as is afforded by nature. When natural means are insufficient and co-operation becomes necessary there are common interests involved which can not be considered separately. Both mutual and individual benefits should eliminate self-interest sufficiently to secure a fair consideration of the merits of the case in hand. It may be said that the improvements made by any farmer in a community indirectly benefit his neighbors. The privilege of improving his land by draining it should not be prohibited either by law or the prejudice of his neighbors, especially when no injury can be suffered by the neighbor occupying lower land. Assuming that the owner of land occupying a higher level desires to drain, and has no outlet without crossing the land of his neighbor, he should not be enjoined from doing so at his own expense, even when no good will incidentally be conferred upon that neighbor. On the other hand, if the drain so constructed will benefit his neighbor the latter should bear a proportional part of the expense of the work done on his own land. A case can scarcely be found where the making of a drain for the benefit of upper land and conducting it through that occupying a lower level can work any injury to the lower land. It is in accordance with justice and equity, however, that the work of improving the upper land by artificial means should be done in such a way that no injury will result to anyone. In case this is unavoidable, remuneration should be made to the person suffering injury. Some farmers are unintentionally captious in cases where the improvement of a neighbor's land requires some concession on their parts. At the same time there is great reluctance on the part of some to consider the rights of the owners of lower lands over or through which drainage must be obtained. Many misunderstandings in the adjustment of these matters arise from a misconception of the true office and results of land drainage in general. It is a subject whose appearance varies according to the viewpoint of the observer, and so requires candid consideration by every one interested in carrying out the work of a character covering more than individual interests. The questions arising under this head are so diverse and include work of such magnitude that a comprehensive knowledge of the subject is a necessary prerequisite in arriving at any just conclusions.

DRAINAGE OF IRRIGATED LANDS.

The soils in most irrigated regions are deep and loose, containing a small percentage of clay, but rich in available palnt food. They are finely divided and possess great capillary attraction for moisture; moreover, their physical structure is such that they are easily kept in prefect condition by judicious cultivation. Further than this, they permit of the ready passage of water through them after the capillary spaces have been filled. The rainfall is so far deficient that water must be obtained from supplies diverted from mountain-fed streams, brought to the land and distributed by ditches. The effect of this application of water to soils, under judicious management, is remarkable, as the abundance and value of the products obtained from such land have proved. *(Continued.)*

THE PRIMER OF IRRIGATION.

Chapter XVI.

SUPPLEMENTAL IRRIGATION.

When the subject of irrigation is broached one immediately thinks of an arid region or one in which the ordinary rainfall is inadequate to raise a crop to maturity or to raise one sufficiently profitable. In such regions irrigation is practiced all the time, from the planting of the seed to the maturity of the plant, and even afterward it is necessary to again irrigate for the purpose of fitting the soil for cultivation for the planting of another crop. The rainfall is totally disregarded. Irrigation is a necessity.

But in the humid regions where there is an adequate rainfall, or at least from thirty to forty inches of rain precipitated upon the soil during the year, irrigation has until quite recently in this country been looked upon very much in the light of an unnecessary luxury, a refinement of agriculture suitable for gentleman farming and not to be encouraged when it comes to general farming. The idea of irrigating in the humid regions is growing stronger, however, and it will not be long before irrigation will be as common in Massachusetts and New York as in Arizona. Indeed, it must come to that or the humid States will be compelled to go entirely out of the business of crop raising, for the productions of the soil in the irrigated regions are so enormous that the humid or rain farmer will not be able to compete. This irrigating in the humid regions where there is an abundant annual rainfall is what is termed "supplemental irrigation," inasmuch as it supplements the rainfall or makes good its deficiencies and uneven distribution during the periods of the year of the growing season.

Supplemental irrigation, though quite recent in the United States and even now looked upon with disfavor, has been practiced in Europe for centuries where the rainfall is sufficient to raise crops without irrigation, as in our humid regions. Germany, France, Italy and the British Isles have practiced it with profit and success, and to fail to irrigate is to be guilty of bad husbandry and careless of profits.

To state the proposition of supplemental irrigation broadly, it removes the element of chance in all farming that depends solely upon the water precipitated from the clouds naturally. No farmer guesses at his seed, but selects the best variety with the greatest care, even experimenting with a small quantity before trusting his entire harvest to the probability of failure. So also does he choose his implements, his stock, and he prepares his soil in the most approved and certain manner, but when he considers the probabilities of the element favoring him with bountiful returns he shuts his eyes and draws for trumps when he might have the winning cards in his own hands by the exercise of his common sense.

There are times when the skies are as brass and the earth like a burning furnace, then his hopes are blasted and he grieves. There are also times when the rain comes just right and the earth laughs with a harvest. Then the farmer rejoices and says: "We have had a good crop." But if he will stop to consider and look back a few years, go over his ledger of balances, he will discover that in the space of five years, for instance, he has had three bad crops and only two good ones. Why? The only answer is: There was not rain enough to mature the crops; there were several dry spells right in the growing season when the plants were seriously injured and no amount of after rainfall —nay, a deluge—could restore them their lost vitality.

It is not the desire of the author to argue in favor of supplementary irrigation in the humid regions, for that is bound to come to the wise farmers, but there are many who may not yet be assured of the necessity of it, or to whom the knowledge of it has not yet come, and to whom he will only say: How much better it would be if a farmer could plant with the certainty that every crop would be uniformly abundant, and that, too, year after year without a single break.

He can accomplish this by simply utilizing the surplus water which he watches go to waste without raising a hand to stop it or to store it up against the time of dire need. It rains, says the rain farmer, therefore why pour more water on the soil? True, but there is a story to tell which will illustrate that sort of argument better than pages of theory. It is an old one to the middle-aged, perhaps threadbare, but new in this connection, for which reason it will bear repeating. This is the story, or, rather, anecdote:

A stranger once traveling through Arkansas one fine day came across a rain farmer sitting in the sunshine at the door of his cabin fiddling away for dear life on a cracked fiddle. Dismounting, the traveler passed the compliments of the season and looked around to take in the situation. It happened that a large hole in the roof of the cabin caught his eye.

"Why do you not mend the hole in your roof?" inquired the stranger.

"'Tain't wuth while, stranger; 'tain't a-rainin'."

"Well, when it rains you will have to mend it," said the stranger, sarcastically.

"Dunno about thet, mister; it mought be too wet to fix when it are a-rainin'."

It seems strange to unaccustomed eyes to see an irrigation farmer of the far west pouring water on his soil with the rain falling in torrents.

A Bostonian who was passing through the Sacramento valley in California in a comfortable Pullman car during a heavy rain noticed a farmer busily engaged in irrigating his land without noticing the downpour.

"Just look at that fool watering his land when it is raining so hard."

"He's no fool," said his companion, who happened to know something about irrigation, "but a wise man. He knows that the effects of the rain will last about three days, but that the irrigation water is good for two weeks."

IRRIGATING IN A HUMID REGION.

The experience of Dr. Clarke Gapen, at one time superintendent of the Illinois Eastern Hospital for the Insane, may do much toward clearing away any doubts the reader may entertain as to the wisdom of irrigating in a humid region. Says the doctor:

"For two years the garden crops on about ninety acres of land were almost a total failure, the loss not only depriving the inmates of the institution of fresh vegetables, but it was a financial loss. In the spring of the third year I suggested to the Board of Trustees the extension of our water mains into the garden and

into certain lands which it was proposed to use for garden purposes, consisting of about 150 acres. This was agreed to, and we proceeded to lay about 4,000 feet of water mains out into the farm. As there was some delay in completing the work, our irrigation was not begun until some time in June. We had in the meantime, however, planted a portion of the land in fruit trees and berries, and the remainder was planted in vegetables. As soon as the pipe laying was completed the water was turned on and irrigation of the entire tract begun.

"The following results show the profit of the undertaking:

Beets, 4 acres, 1,960 bu. at 30c	$ 588.00
Cabbage, 15 acres, 1,498 bbls. at $1	1,498.00
Cauliflower, 3 acres, 81 bbls. at $1.50	121.00
Cucumber, 3/4 acre, 184 bu. at 60c	110.00
Lettuce, 3/4 acre, 101 bbls. at $1	101.00
Water and musk melons, 7 acres, 16,000 at 3c	148.00
Onions, 3 acres, 245 bbls. at 75c	183.75
Peas, 5 acres, 250 bu. at $1.25	323.75
Radishes, 3 acres, 304 bbls. at $2	608.00
Tomatoes, 6 acres, 1,360 bu. at 30c	408.00
Turnips, 15 acres, 3,000 bu. at 30c	910.50
Potatoes, 25 acres, 3,000 bu. at 30c	900.00
Greens, 2 1-3 acres, 500 bu. at 25c	125.00
Rhubarb, 1/2 acre, 261 bbls. at 50c	130.00
Total for 90 1/2 acres	$6,478.40
Total for 1 acre	73.57

"While it is conceded that this does not show an excessively large yield, it must be borne in mind that is far greater than the average yield in the regions round about during the same season, and that irrigation was begun very late in the season. Moreover, the ground was newly broken and had never before been used for vegetables.

"The cost of laying the pipe was about $1,500, or, say, $10 per acre. The land before the pipes were laid would have been regarded for agricultural purposes as at a high price at $100 per acre; it now has a producing value to the institution of $500 per acre.

TWO METHODS OF APPLYING WATER.

"In applying the water at the hospital we used only two methods—the ditch and the flowing. In both cases the water was conveyed in large ditches meandering in conformity with the contour of the ground, running often by very circuitous routes to the desired points. There it was diverted into furrows made by what is called 'middle breakers,' or double mold board plow between the rows of corn, potatoes, cabbage or whatever the plant; or by the flooding method it was spread out over a leveled space ten to fifteen feet in width, with ridges six to eight inches high, thrown up to separate these spaces from each other, and occasional cross-ridges if the slope of the ground was steep. We kept the slope of the land constantly in mind and we found it always best to always begin at the lowest point and work up or backward. In irrigating the orchard we ran a furrow on each side of each row of trees and allowed the water to run slowly throughout its length. For orchard purposes we find two irrigations sufficient, one early in the spring and the other just as the fruit begins to ripen. As the trees grow the irrigating furrow is run farther and farther away from the trees."

Dr. Gapen is of the opinion that irrigation has a much larger future in those portions of the country where the rainfall is reasonably large than even in the dry regions, because there is a larger supply of water which can be utilized and, of course, can be utilized to a greater extent. Long continued experiments in the direction of supplemental irrigation have indeed demonstrated beyond any doubt that crops may be doubled and quadrupled. The irrigation system adopted at the institution of which Dr. Gapen is superintendent required from 100,000 to 200,000 gallons of water per acre during the growing season. He estimated that at least two inches of rainfal were necessary for even a light irrigation, approximately 55,000 gallons, being at the rate of 27,154 gallons of water for one inch of rain, and that to give two good wettings to the soil at least 220,000 gallons, or about eight inches, should be given each acre. This was modified to about 100,000 gallons per acre for each wetting. More water, however, could be used to advantage, for the reason that in humid regions a 70 per cent saturation by bulk will give the best results.

As to the expense of the supplemental irrigation at the Illinois institution, above referred to, it cost $3.00 per 1,000,000 gallons to deliver the water at the point required. At this rate the cost of delivering 100,000 gallons, the amount necessary to irrigate one acre, was only 60 cents per acre for two good wettings. This expense was much greater than that incurred by ordinary pumping or lifting, for the reason that there was maintained a pressure of fifty pounds, which required high pressure pumps. The piping was the best grade of cast iron pipe, laid entirely below the frost line, using three, four and six-inch pipe, which cost from 20 to 30 cents per foot.

With a farm located on the bank of a stream, or with an inexhaustible well, it is not difficult to understand that the expense would be much less. The fact remains, however, that with the most expensive appliances supplemental irrigation is productive of double profits, and therefore it is a system not to be rejected without at least a trial of its merits.

DRAINAGE INVESTIGATIONS.

Office of Experiment Stations.

The office of experiment stations of the United States Department of Agriculture has issued a report on the drainage investigations carried on during 1903 under the direction of Elwood Mead, chief of irrigation and drainage division of this office, by C. G. Elliott, expert in charge.

The object of the report is to show the possibilities of drainage and the methods of accomplishing it most effectively and economically. The work carried on by Mr. Elliott during the past year included plans for reclaiming alkali lands at Fresno, Cal.; surveys and investigations in Yakima and Atanum Valleys, Washington, and in Grey Bull Valley, Wyoming; plans for the drainage of overflowed bottom lands in the Missouri Valley in Iowa, and experiments with the use of drains to prevent hillside erosion in Georgia.

In the district about Fresno, Cal., where the water plane in the once dry soil had reached, in places, a distance of but two feet from the surface, the injury to crops from an excess of water in the soil and the accumulation of alkali was apparent over a large area. Surveys were instituted to determine the proper arrangement of drain ditches. Plans were made for two

methods of drainage, one employing open ditches, the other drain tile. The drain-tile plan, while making the first cost less than for the open-ditch system, since no provision has to be made for the land taken up and the crossings of roads and irrigation canals, requires ample provision for securing the drains and operating pumps.

The abundance of the water supply and the apparent necessity for its liberal use upon the lands under Sunnyside Canal, in the Yakima Valley, Washington, have hastened the filling up of the soil with surplus water. At the edges of the slopes are saturated spots and in many places alkali has accumulated to an injurious extent. Test wells were sunk and a close study of the fluctuations of the water level was made. The source of the oversupply and the nature of the substrata having been determined, the depth and grade of proposed drains were shown upon a map furnished to the owners.

In this, as in all other cases, it is evident that a thorough knowledge of conditions governing the movement of water in the soil is essential. The expense in each case is estimated according to local conditions and an ample margin of safety is allowed. In each district the disposal of drainage water receives careful attention, and cautions as to the necessity for studying local conditions are added. The top and bottom widths necessary for permanent maintenance are carefully estimated. The ditches are planned to provide also for winter storm water. The attention given to these typical cases shows the value of the expert advice on questions of drainage provided by the Department of Agriculture.

In the Atanum Valley, in order to remove alkali from abandoned lands and protect hop fields from its inroads it is necessary to drain the subsoil so that the alkali dissolved and washed down from the surface may be carried away from the lower levels. Directions for making such ditches are part of the report. The plan for the drainage of a farm of eighty acres in this valley, while applicable to particular conditions, suggests how drainage may be made to counteract excessive subirrigation. Practical work in the removal of alkali is illustrated by the description of the reclamation of seventy-two acres in Kittitas County, Washington.

Although it is but seven years since irrigation began under the Farmers' canal in Grey Bull Valley, Wyoming, there are boggy tracts of considerable extent at the foot of the benches which are now given over to aquatic grasses where formerly some of the most productive land of the valley was found. In other places the deposits of white alkali have destroyed the fertility of the soil. While there is a gravel vein of great thickness that receives and conducts away from the benches the surplus water applied in irrigation, a stratum of impervious clay finally arrests the downward course of the water and turns it to the surface at the foot of the benches and alkali accumulates wherever the surface is exposed to evaporation. The remedy suggested is to deepen the ditches provided for waste until they strike well into the gravel, at the same time arranging them so that the seepage water collected in them may be discharged into ditches lower down, thus adding somewhat to the supply. More frequent watering will be required on this area than on land with clay subsoil, but the distribution of water should be more directly and carefully made. That a provision for disposing of the excess of water would also relieve the land of alkali deposits is evident from the fact that the alkali washed out of this gravelly bottom land at each irrigation, if left during one season, would destroy a crop.

An entirely different problem in drainage is presented by conditions along Missouri River in western Iowa. This very fertile country is lower than the banks of the rivers which form its boundaries and is threatened with overflow whenever the river rises. Two features are included in the plans for relieving this situation. First, the construction of a ditch to carry water from the Little Sioux across the intervening triangle and deliver it into the more capacious channel of the Missouri; second, the straightening of the channel of the Little Sioux by cutoffs. By the wise provisions of the State drainage laws the entire cost of these improvements can be met by issuing bonds, which will be amply covered by the returns from the reclaimed land. While the need of underdrainage is not lost sight of, the emphasis here and in the districts of Hancock County, Iowa, is laid upon the improvement of the natural channels for carrying off water.

The prevention of hillside erosion by underdrains was the object of an experiment made upon a farm in northern Georgia. Lines of drain tile were laid across the slope to intercept water, which, oozing through the soil and cropping out at some lower point on the surface of the hill, formed seeped spots, the starting points of surface washing, which in time made wide and deep gullies that necessitated the abandonment of the whole field. After the tile was laid the gullies were filled and the surface graded and dressed in such a way that all surface water would be scattered instead of concentrated. In the season that has elapsed since the improvement was made a crop has been raised and no washing has occurred.

Throughout the report the necessity for making complete preliminary surveys and for gathering full data in regard to each locality is made apparent. The question of the adaptability of different methods of drainage is in each case considered, while the legal and economic aspects of each problem are not lost sight of. These clear statements of practical problems and their solutions are a valuable addition to the library of the intelligent farmer and should have careful reading.

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

New York, July 20, 1904.

The Irrigation Age, Chicago, Ill.

Gentlemen: We would like very much to obtain a recent and authentic list of irrigation companies in the United States, particularly those located in the South Central States and Texas. If you can tell us where we can find such a list, kindly oblige us with the information.

Very truly yours,
International Steam Pump Co.,
George H. Gibson,
Manager Dept. of Publicity.

CASPER, WYO., July 1, 1904.

THE IRRIGATION AGE, Chicago, Ill.

Maybe you have been poisoned by the venom of the Talisman. Give an account of yourself.

We have had considerable moisture from above this spring, but there is very little snow in the mountains and it looked for a while that a total abstainer would not be in it. A friend tells me that they are very saving of water in his locality, so much so that they wash their feet in the dish water and scrape the kids with curry combs.

Yours very truly, J. W. PRICE.

TRINIDAD, COLO., July 15, 1904.

THE IRRIGATION AGE, 112 Dearborn Street, Chicago, Ill.

Dear Sirs: We have been trying to find the factory making what we have heard described the "Lambert Rotary Pump." Can you oblige us with any information about it? The only thing we know is that it is either a rotary or centrifugal pump of large capacity and of course is run by power. If you can give us any information in the matter, we assure you that it will be greatly appreciated and the favor will be reciprocated whenever possible. Yours truly,

THE F. BURKHARD SADDLERY & IMPLEMENT CO.

AUBURN, IND., July 10. 1904.

THE IRRIGATION AGE, Chicago, Ill.

Gentlemen: Will you kindly answer me through the columns of your paper whether or not that irrigation project in Crook County, Oregon, is started? And who is the proper person to write to about it?

Yours very truly,

A. G. MOORE.

The Deschutes Irrigation & Power Company, which absorbed the water rights and segregated tracts of the Pilot Butte Development Company and the Oregon Irrigation Company in February of this year, has its headquarters at Bend, Ore. Active construction on its main canals was started in March, since which time about twenty-five miles of ditch have been built, covering a territory of nearly 25,000 acres lying immediately north of Bend. A large portion of this land falling under the ditch has been sold to settlers and it is expected that a considerable area will be under cultivation inside of another twelve months. It is the intention of the company to begin active construction work soon on another of the main canal lines which, when completed, will reclaim the balance of the company's segregation, amounting to 150,000 acres.

Communications should be addressed to the Deschutes Irrigation & Power Company, McKay building, Portland, Ore., or to W. E. Guerin Jr., Bend, Ore., who is in active management of the company's business at the seat of their operations.

MELBOURNE, AUSTRALIA, June 21, 1904.

THE IRRIGATION AGE, Chicago, Ill.

Gentlemen: I post you on a Leader newspaper; also will send you a couple of photos concerning a trial of the Bennett American Tile Ditcher. I have for years tried to sell one of these machines and have at last found a customer in Mr. G. O. Webb, orchardist, a tile drain maker, Somerville, Victoria. At the trial I took out all the numbers of THE IRRIGATION AGE we have received from you and gave them to prominent orchardists, viz.: Mr. T. H. Grant, Pakersham, Vic., who has about twenty-five miles of drain in his orchard; Mr. W. S. Williams, lemon grower, Doncaster, Victoria; Mr. Charles French, Government Entomologist, Law Offices, Melbourne, Victoria; Mr. H. Jennes, Melgrave; Mr. J. Herbert, Diamond Creek; Mr. J. R. Warren, Harcourt, and others. If you will send me out any back numbers, I will give them to good growers.

We also want catalogues on tile making machines, also drain tools. I am trying my best to make our farmers go in for drainage. You have a good friend in Mr. D. M. Dow, of the *Leader*. You might drop him a line, or send a short article on the benefit of drainage to his paper.

I will let you know later how Mr. Webb gets on. He has two contracts to proceed on at present.

With best regards and all success to drainage,

Yours,

J. DAVIES.

TUCSON, ARIZ, July 15, 1904.

EDITOR THE IRRIGATION AGE, Chicago, Ill.

Dear Sir: On my way home from the East I laid off in El Paso three days and naturally made inquiries into the doings of Maxwell, Boothe & Co., referred to in your last two or three issues. I was at first afraid that your open references to these parties and their little games were too pointed and nothing more than a personal "tiff" between two editors publishing papers on similar subjects, but my mind on this has been thoroughly disabused, and I have no hesitation in giving you a few concentrated facts that I can vouch for.

In the first place, why did G. H. Maxwell, unsolicited, come forward with cash or railroad passes for the whole of the El Paso delegation to the Ogden congress, after they won the day at Ogden? The acceptance of this much more or less put El Paso under an obligation to this pair of "lobbyists" and "land grabbers." From what I can learn, early in the year the chief aide of G. H. Maxwell, one C. B. Boothe, appeared in El Paso as the "great I am" on all matters appertaining to the coming Irrigation Congress to be held there in November next. He called meetings and demanded offices for this and that party, an assistant secretary, etc., and went so far as to make many of the El Paso people believe that neither Senator Clarke nor the Hon. H. B. Maxson (president and secretary, respectively, of the coming congress) were anything more than second fiddles to the "I am" and so matters are going on. Everything has to be referred to Mr. Boothe. According to a local paper, the El Paso Irrigation Committee could not close tenders for the building of the proposed Congress Hall unless Mr. Boothe was consulted. He further led people to believe while there that he held the position of secretary to the National Irrigation Congress, but this one of the local newspapers corrected.

I was introduced to the new local secretary, who, although a mining man, is known to be pushing affairs to make this the most notable event in the annals of the National Irrigation Congress, and every visitor will be received with open arms and will be guaranteed a rare, good time while in the city of El Paso. I do not think that as a body the local people see through the two-faced intentions of Maxwell & Co., but I met one or two who seem to be fully informed on all that is going on, and appear to know Maxwell and Boothe as one and the same. Boothe appears to be the best diplomat and talker and appears to have the most "gall" and probably this is why he is sent forth to make arrangements and also do the "lobbying" in New York. It is to be hoped that should this combine make a renewed attempt to get control of affairs, they will be sat upon from the start, for should any private individuals, the acknowledged agents of land grabbers, get into national affairs on so important a matter as "irrigation," which has become a national question, such supporters of the National Irrigation Annual Congress as Senator Clarke, Governor Warren, Elwood Mead and all those who at great expense and time, have by their presence and good common sense, made each one and all of the past meetings an unqualified success and advanced the good cause for the benefit of the whole nation, shun with disgust the idea of ever being connected with the National Irrigation Congress in the future. It is the opinion of those well informed that this combination is using every influence to secure a vote at the coming congress favoring a resolution for the repeal of the commutation Clause of the Homestead Act, the Desert Land Law and the Timber and Stone Act and they, Maxwell and Boothe, state that they have El Paso "cinched" on this proposition. They claim the vote of the full El Paso delegation on the subject. How could they vote otherwise when Maxwell, Boothe & Co., perfect strangers to all hands, before the Ogden congress handed them free passes for their whole trip. On the strength of his appointment, Mr. C. B. Boothe has placed his "boss" Maxwell in the position of chairman of the "Land and Water Section." So far things have been going well for them, but how people like them, who in their monthly paper called the "Talisman" claim to be the true friends of the homesteader and bona-fide settler, can reconcile the evidence given by Maxwell in his examination before the House Committee on Irrigation of Arid Lands on April 1st, last, viz.: that he had spent over $60,000 in the interest of land-grabbers during the year, is more than I, or many others, can see through, except in one light.

The combine may be clever in a way, but it would be a very grave error to allow such parties to get control of national affairs, much less one of so much importance to the

whole country as irrigation. I can not help thinking that the time has come for one or more parties to frame charges against this so-called "National Irrigation Association" for attempting to divert the Irrigation Law of Congress from the beneficial purpose to provide homes for American citizens, actual homeseekers, into a source of private speculation. Should the President, who has made so many friends out West by taking up the cause of irrigation as warmly as he has, get wind of this combination, I have no doubt he would order an inquiry such as has been carried out in the postal and other frauds which have resulted in the exposure of so many individuals who were being looked upon by their fellow beings as saints and not sinners. I hope to return East via El Paso shortly and shall not fail to keep in touch with you in regard to general ideas on this subject, as they come under my notice during my run through Utah and Colorado.

Yours respectfully,

E. W. Hart.

Peoria, Ill., July 11, 1904.

Mr. D. H. Anderson, Chicago, Ill.

Dear Sir: Your article on "Sub-Irrigation" in your last issue of The Irrigation Age has the right kind of a ring to it and many others are seeing it in the same light! Too much can not be said of sub-irrigation, as it is the only practical system before the people for draining and fertilizing the soil, saving 50 to 75 per cent of water and the same percentage in labor. Stronger and healthier trees or vines, more and better fruit. All these points mean something and are worthy of the consideration of the public. Water is too scarce in the arid districts to feed the sun 50 to 75 per cent of it, and this is not all. The flooding with water is injurious to any land. It not only leaches the soil, but causes it to bake and get hard, which is very injurious and many other things that lack of space will not permit me to mention.

Two points in your article were not plain to me:

First. Is the running of water through the laterals without the aid of an air vent and what means have you to tell when the system is full of water.

Second. By what means do you retain water upon the side of a hill, as water will naturally run to the lowest point when the pressure is shut off?

These points are very important in sub-irrigation.

Think your journal (by exchanging thoughts upon this great subject, irrigation) is doing much to educate the public along this line and the time will soon come when each person will have his own "Irrigating System," indepndent of the "Water Trusts" and by so doing will open up millions of acres of land that can not be irrigated in any other way and also add a million more homes in the arid West.

With best wishes and success, I remain,

Yours truly,

W. A. Lee.

Bloomington, Jackson County, Ala., July 19, 1904.

The Irrigation Age, Chicago, Ill.

Dear Sirs: I am in need of a hydraulic pump. I have a small one at work, but it does not give satisfaction. I have plenty of pressure with ten foot fall and lift twenty feet, but I want something to throw plenty of water, so as to irrigate a garden and to attach a hose. If you can give me information as to who has a good variety, I would appreciate it. I am a subscriber to The Age.

Yours truly,

J. F. Bell.

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Myers Bulldozer Power Working Head

No. 359. Bulldozer Working Head, 5, 7½ and 10-inch stroke. Price $75 00

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Fig. 413.

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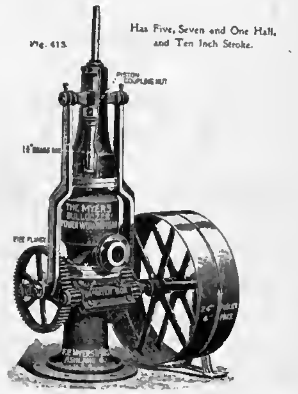

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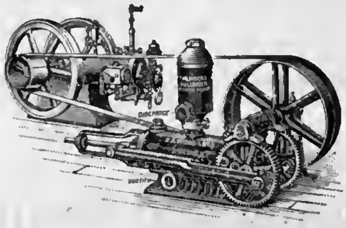

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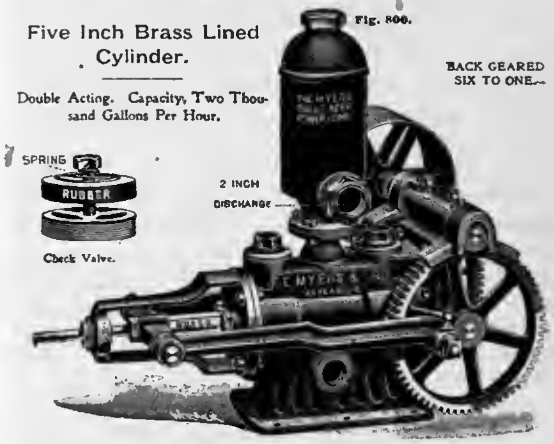

Check Valve.

Fig. 800.

BACK GEARED SIX TO ONE.

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No. 353. Bulldozer Pump, 5-inch Brass Lined Cylinder, 5-inch stroke. Price 75 00

No. 363. Bulldozer Pump, 6-inch Brass Lined Cylinder, 12, 16 and 20-inch stroke. Price 250 00

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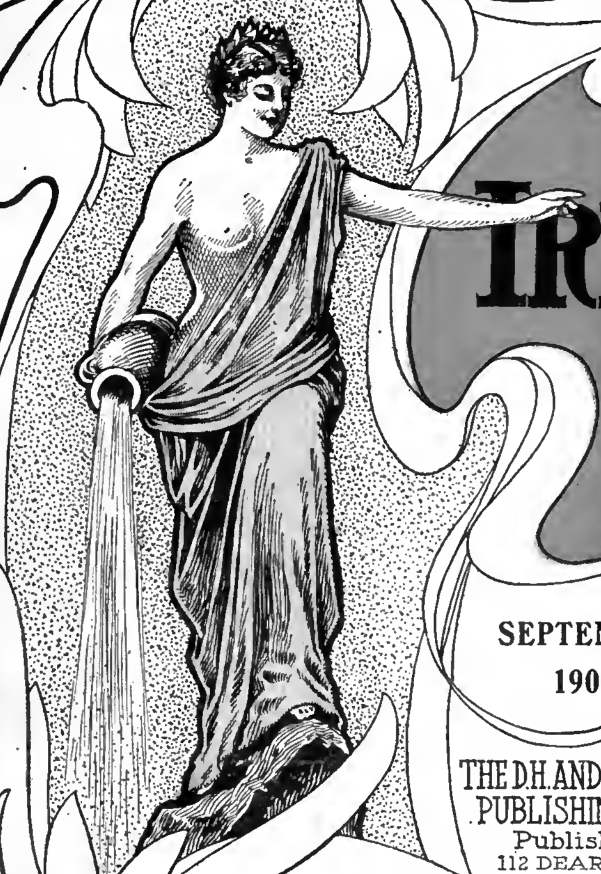

THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

SEPTEMBER, 1904.

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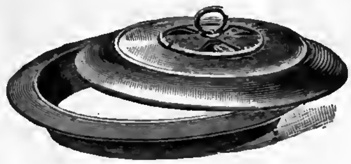

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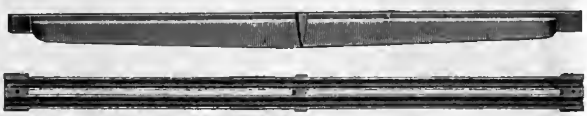

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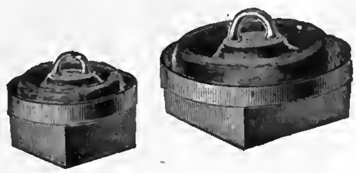

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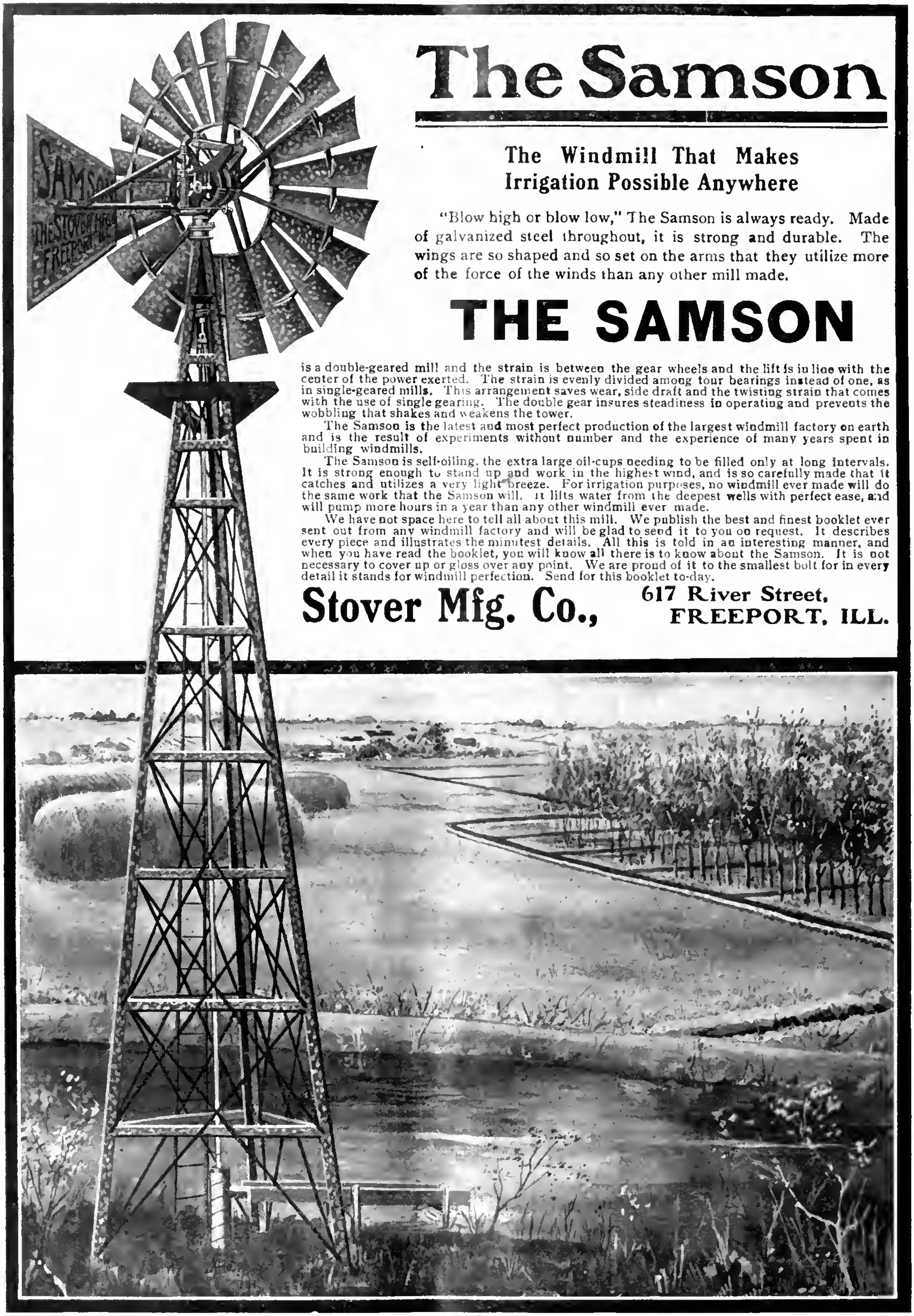
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"Blow high or blow low," The Samson is always ready. Made of galvanized steel throughout, it is strong and durable. The wings are so shaped and so set on the arms that they utilize more of the force of the winds than any other mill made.
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is a double-geared mill and the strain is between the gear wheels and the lift is in line with the center of the power exerted. The strain is evenly divided among four bearings instead of one, as in single-geared mills. This arrangement saves wear, side draft and the twisting strain that comes with the use of single gearing. The double gear insures steadiness in operating and prevents the wobbling that shakes and weakens the tower.
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THE IRRIGATION AGE

VOL. XIX CHICAGO, SEPTEMBER, 1904. NO. 11

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION — THE DRAINAGE JOURNAL — THE IRRIGATION ERA — MID-WEST — ARID AMERICA — THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

Newell's Interview. The interview of Mr. Newell's, published elsewhere in this issue, and the reply of Governor Chatterton of Wyoming are deserving of some study and further investigation. Mr. Newell has always taken the position that only the work he does is worth consideration and he makes sweeping statements regarding the large irrigation companies of the West that are calculated to discredit such development as has taken place under their management. A few years ago Mr. Newell said that investment in irrigation works on a large scale was not profitable, and the truth is that but few companies have received large returns from the money expended. It is also true that many of the irrigation companies of the West have sold land with a water right at half the price the Government will find it necessary to charge. It is also true that the water rights of these companies have been perfected and the people who bought their lands are today as secure as local laws, under which the Government must operate, to a certain extent, can make them.

Such statements coming from a man who stands high in the service of the Government should have weight and would, usually, be accepted as an approximation of the truth. Mr. Newell does not name any of the canal companies to which his remarks might more particularly refer, but would lead one to believe that what he has said has general application. Would he care to say that his statements refer to the Washington Irrigation Company of the Yakima Valley in the State of Washington, to the Bear River Canal Company in Utah, to the Grand Valley Canal Company in Colorado, to the Pecos Valley Irrigation Company in New Mexico or to the Wyoming Development Company of Wyoming? He knows, as all know who have visited these States, that the operation of these companies has made possible the settlement of large areas by comparatively poor people; that the canal companies have carried these people on their books for years in many cases; that only a fair return has been received or is expected from the money invested, and in some cases no return has yet been made. He also knows that the above named companies are only a few among a hundred and more that might be mentioned and put in the same class.

As before stated, Mr. Newell never recognizes the value of any work unless done under his supervision. The Irrigation Act, under which he is operating, has as yet accomplished nothing for the people. It is in an experimental stage and it would seem that Mr. Newell would prefer to show us what can be done under Government control before he discredits those who have risked their money and employed the best years of their lives in developing the West.

Mr. Newell's remarks would come more gracefully

from a western man and an engineer who had made surveys or built canals and reservoirs or one who had actually invested in irrigation works. As THE AGE has already stated, Mr. Newell has never performed any such work and is not able to view irrigation development from the aspect of the practical engineer or constructor. Those who have read "Influences in the National Irrigation Program" understand how he secured his place and to whom he owes it today, and such persons will not be surprised to read his indiscreet remarks made for publication in the *Omaha Bee.*

Irrigation Problem. The aim of THE IRRIGATION AGE is to encourage the further development of irrigation. When we contrast the progress which has been made in arid America with conditions there two decades ago, we are justly proud of our share contributed. But irrigation is an evolution. A century hence and there will be problems unsolved. We can not, therefore, rest content, but must press onward and onward with the work.

Colorado claims, perhaps justly, to lead in the law and practice of irrigation. Its agriculture is already vastly more important than its mines. And yet T. C. Henry, its most prominent votary, publicly asserts that there is present need and opportunity to employ fifty million dollars in outright and auxiliary construction, including storage, in that State alone. He says the lands there which have a full supply of water are in local demand at $100 per acre and that until the million or more acres now "under ditch" but partially supplied, are supplemented or new systems built, it is unnecessary and unwise to invite immigration unduly lured by glowing results of Southern Colorado cantaloupes, Northern Colorado potatoes or western slope fruit. We know that such is the situation in parts of California and Arizona, as well as Oregon and Idaho. How shall the demand be met? How shall the capital be secured? The need is urgent and large sums separately and collectively are required. The Government, through the Reclamation Act, is helping greatly. But of the 80,000 acres for instance, proposed to be reclaimed by the Gunnison Tunnel project, fully four-fifths are private lands and under canals, some of them in operation for the past twenty years. In that case, therefore, it is supplementary supply mainly which is needed and which the proposed $2,500,000 Government outlay is to meet, and if completed within the five years estimated, the territory so "reclaimed" is a mere spot in a remote section of that State. This enterprise is likely to consume the Colorado allotment for ten years. If the present and increasing land hunger is to be appeased, clearly large private capital must be employed.

It is useless now to discuss the causes which led to the losses and disappointment in irrigation enterprises a decade or two ago, in the pioneer period, as it would be profitless to rehearse the story of the panic of '93 or of Chicago in '57. It is enough to know, however, that owing to imperfect local laws and because of the burnt child's dread of fire, outside capital will no longer undertake these large projects and chance the sale, or risk the rental of water for its return. The great increment which has come to irrigated land has not been fairly shared by the men whose capital and enterprise made such increment possible. It seems to us that the solution for further and immediate considerable development lies through the irrigation district laws enacted by several of the arid States. As our readers generally know, this law is analogous to the Illinois Drainage District Act. The territory to be improved or reclaimed is organized into a district, quasi-municipal, like a school district, and bonds voted to construct or improve on a lien on all the lands irrigated, principal and interest collectable and paid through taxation, like other bonds. By this plan the affairs of the district from its initiative are in the hands of those directly interested. It is asserted that nine-tenths of the attendant friction and antagonism grows out of administration—even when the parent company itself is a large land owner and therefore incited to wise and economic effort.

Difficulty is being experienced in marketing such bonds. The scattered owners of the lands to be reclaimed are, of course, themselves unable to take up such large holdings, nor is there an available supply of capital in the neighboring towns and cities; hence in eastern or middle west money centers must the quest be made. Here, however, a knowledge of the subject of practical irrigation is as yet confined to the very few, and such securities are almost wholly new to the investing public. Here, too, the separate and virgin factors of land and water have little value apart, until brought together by the very outlay through the bonds made in advance.

The ordinary showing of considerable taxable property like a city is necessarily lacking at the start. The situation is somewhat similar to the homesteader when he applies for a loan before he has "proved up." His land being unpatented and therefore untaxed, he can make no showing by the tax list, and still the basis for the loan may be as substantial as otherwise. We believe the whole plan of irrigation development and administration embodied in the District Law is almost ideal. We believe, also, that the security such bonds offer has great intrinsic merit. Even a school district could not exist if its territory were still arid, and yet its bonds are sought for at a low interest bearing rate, while the irrigation bond, the primary security, may be difficult to market at a higher rate. We are confident this anomaly will not long continue.

The various local cities through their banks, Boards

of Trade, etc., and particularly the railroads, should take up, investigate and vouch for meritorious district projects and co-operate to interest their respective eastern connections in these securities. The law has unusual safeguards, which heeded and enforced by public spirited citizenship as suggested, should soon solve the problem and inaugurate the great work now needed and now lagging.

POLITICIAN AND EDUCATOR.

Hon. John H. Worst, a Talented and Influential Man in North Dakota.

C. C. BOWSFIELD.

Hon. John H. Worst, president of the agricultural college at Fargo, is one of the grand characters of the Northwest. He has been a citizen of North Dakota for twenty years and is a leader of thought in the young State. Both as a politician and an educator Mr. Worst has been an influential citizen from pioneer times to the present.

He was in the first North Dakota legislature as senator from Emmons county and held that position for five years, when he was elected lieutenant governor on the ticket with Governor Roger Allin, of Walsh county. Before the expiration of his term as lieutenant governor Mr. Worst was chosen to the presidency of the North Dakota Agricultural College. While in the senate, and during the exciting campaigns which marked the earlier political history of the State, he won an enviable reputation as an orator. In fact he is one of the most brilliant public speakers in the Northwest. His information is varied and he entertains his audiences by a fine command of language and a logical presentation of facts.

As the head of the agricultural college he has a splendid opportunity for educational work. For this line of duty his early training abundantly fitted him. He acquired his education chiefly at the public schools of Wayne county, Ohio; at Salem college, Indiana, and at Ashland university. He is a native of Ashland county, Ohio. After leaving college he was a teacher and editor for a number of years. He also carried on farming in a practical way and understands tilling the soil with the best of men in that vocation. Therefore, Mr. Worst was no mere theorist when he assumed his duties as head of the faculty at the Fargo college.

He is a broad-minded, genial man, true in his friendships and earnestly devoted to high purposes in life. His faithfulness to duty and his correct principles have contributed to his success quite as much as his commanding ability.

Mr. Worst owns a large stock farm in Emmons county, quite close to the Missouri river, at a point adjacent to the Standing Rock Agency and about sixty miles south of Bismarck. It is one of the most picturesque sections of North Dakota. There is a magnificent sweep of prairie on both sides of the Missouri. The graceful curves of the river and a vista of hills in the distance make a beautiful scene. The Chicago, Milwaukee & St. Paul Railway Company, recently extended its line into Emmons county, adding greatly to the value of property and the comfort of the inhabitants. The railway brings the stock ranches and wheat farms there to their full perfection.

CALL FOR NEWELL'S RESIGNATION.

Gov. Chatterton of Wyoming and John T. Alterman of Idaho Think F. H. Newell, Chief of Reclamation Service, Talks Too Much—His Claims Not Founded on Fact.

The following is notable not only because the governor of a great State says it, because it is just and deserved.

Mr. Newell has steadily and, until this, covertly antagonized private enterprise all over the arid West. His hostility extends to individuals as well, often treacherously. It is not enough that his sly malice is leveled at those personally who are promoting large private and independent irrigation enterprises, but he will condescend to display petty slight and spite toward those who will not acclaim him Allah. Mr. Newell is essentially a man of small calibre and vain. Maxwell knows this. He has flattered and cajoled him with the idea that the Government can and should monopolize irrigation development and that he is man enough to direct it all. Newell has surrounded himself with a coterie of men of more or less ability, but whose servility is pitiable and degrading. Maxwell; having busied Newell with that program, is himself interminably manipulating the back door through which his schemes are led up to Newell's sanctum. Mr. Newell is not corrupt. He is simply weak. But Maxwell is the personification of cunning, graft and deceit. He has already immeasureably discredited Newell and bred distrust nearly everywhere. From this time on indignant protest voiced by Governor Chatterton will be reechoed and reiterated. Had Newell been a wiser man, long since he would have cut loose from Maxwell and shunned him as the Evil One. But he is too weak—possibly he is too deeply compromised. The end is inevitable. Mr. Newell will sooner or later be superseded by a man of adequate practical ability—one who is great enough to welcome co-operation from every quarter and through united harmonious and patriotic effort create for himself an enduring monument crowned with laurels proffered by a glad people.

In order that our readers may fully understand this controversy we are publishing in full, interview which appeared simultaneously in a number of metropolitan daily papers. The interview with Mr. Newell immediately follows, after which is given a letter from Governor Chatterton of Wyoming, as well as a letter from Mr. John T. Alterman of Boise, Idaho. In future issues of THE IRRIGATION AGE will appear further information and correspondence on this subject.

Omaha Daily Bee, August 1, 1904.

TWO KINDS OF IRRIGATION.

Government Expert Newell Tells of Work in the West.

WARNS AGAINST WILDCAT SCHEMES.

Many Propositions Are Floated Where there Is No Water Within Reach of the Land.

(From a Staff Correspondent.)

WASHINGTON, July 31.—(*Special.*)—Three hundred engineers, surveyors and helpers in the Irrigation Reclamation Service are out in the field, studying and planning for irrigation projects in the great West. Some few are superintending the actual construction of huge dams and canals. Mr. Newell himself, the head of the

service, has just returned to Washington from a somewhat extensive western trip. He reports great interest throughout the West in the big works proposed by the Government, but sounds a note of warning against numerous schemes and frauds which are being foisted upon various localities as a result of the great interest aroused through national irrigation activities.

"There are many instances of honest, effective and legitimate irrigation works," he said, "where the settlers themselves, or their capital to some extent, have gone in and build the works, owning or controlling them along with the reclaimed land; but I do not know of any of the big private irrigation schemes which are what might be called legitimate development enterprises. They are exploited, probably, more for selling stock and bonds than for watering land. Irrigation development can be compared to mining development. The two are quite similar in their methods of finance. The gold or the copper mine, or the oil which has really proven a good thing, is taken up and operated by its owners. It is made into a close corporation proposition in every case. If, on the other hand, the supply of metal or oil is problematical, then it is made an attractive stock and bond scheme, with glittering letterheads and artistically printed circulars, and other people's money in large quantities is solicited. Attempts are being made to float very questionable irrigation schemes all over the West.

SCHEMES TO SELL STOCK.

"It is singular, too," said Mr. Newell, "how many men of ordinary hard business sense will go into these wild-cat things. A successful grocer, for instance, if he were investing his money in the grocery business, would find out every detail and every 'in and out' of the new business, and would make a close and advantageous deal, will draw his check for some irrigation stocks or bonds in the most trustful and confiding manner—paying for an investment regarding which he knows nothing, and which is as problematical in its returns as the veriest wild-cat mine. Other people make personal investigation. They go over the land to be reclaimed. They see the splendid crops growing on other lands which have been reclaimed, and having 'investigated' they confidently invest, even though a tract of 50,000 acres is to be reclaimed with a water supply insufficient for 5,000 acres. I am mentioning these figures advisedly. There are instances today where irrigation shares are being sold for land containing absolutely no water supply at all, and which can never be irrigated, but will always remain a desert.

"The meanest and most contemptible class of sales are where the promoters hold out the alluring picture to the poor man of family, that he is, by his small, regular contributions, buying a home for himself and his family. Thousands of people in the United States are making such contributions, which they might as well throw into a rat hole."

Governor Chatterton's Letter.

THE STATE OF WYOMING, EXECUTIVE DEPARTMENT.

CHEYENNE, August 18, 1904.

Fenimore Chatterton,
Governor.

D. H. ANDERSON, Esq., Editor, IRRIGATION AGE, 112 Dearborn St., Chicago, Ill.:

Dear Sir—My attention has just been called to an interview with Government Expert (?) Newell, published in the *Omaha Bee*, August 1st, and of which the enclosed is a copy. If correctly quoted, this utterance is an outrage coming from a man whose position—not his knowledge—gives his words the apparent stamp of authority.

He says: "There are many instances of honest, effective and legitimate works where the settlers themselves have built the works, owning them along with the reclaimed land; but I do not know of any big private irrigation schemes which are what might be called legitimate enterprises."

Mr. Newell ought to know that his statement is false, for there are very few instances where the settlers themselves have reclaimed large tracts of land—such people have not the means. When he states that he "does not know of any big private irrigation schemes that are legitimate enterprises" he states what even he knows to be false, for he knows that his chief, the Secretary of the Interior, has approved many such enterprises in the State of Wyoming, and that as a result there has been legitimately reclaimed 166,077 acres by five such enterprises, and that there is at this time 424,953 acres being rapidly and legitimately put under ditch by twelve such enterprises, and all of these enterprises furnish water at a less cost per acre than will the Government, acording to the estimates reported by Newell under the Government plans, as now managed by him.

He says attempts are being made to float very questionable irrigation schemes all over the West. This is false, for there are none such in Wyoming; she is a part of the West.

He says: "There are instances where irrigation shares are being sold for land containing absolutely no water supply at all and which can never be irrigated, but will always remain desert." He knows that such a condition can not exist under the Wyoming irrigation laws.

There may be fake irrigation schemes, but they are the exception and not the rule, as Newell states. He should confine himself to facts, not sweeping statements, and come forward like a man and name the fakers; but no, under the influence of Maxwell, he uses every effort to discredit large numbers of legitimate enterprises by general statements.

We of the West had hoped the National Government would co-operate with us for the reclamation of the arid lands, but unfortunately the department, through the action of Newell, its chief irrigation officer, antagonizes every effort of our home people. We feel that his statements, if he is correctly quoted, are not only false, but maliciously so, and that, therefore, he should be dismissed from the service. Let us have a practical man in this department and stop newspaper interviews containing false statements and antagonism to home enterprise. Let us have a man who can realize that up to this time the entire work of reclaiming vast areas from a desert condition has been by private enterprise and that the Government work has only just entered upon its experimental stage. Let us have a man who is competent to expend Uncle Sam's irrigation funds in practical works and not waste it in experimental red tape.

It is time the interested arid West took hold of this matter and made a movement looking to the appointment of a capable and practical man.

Yours very truly,
F. CHATTERTON.

Letter from John T. Alterman.

Boise, Idaho, Aug. 20, 1904.

Irrigation Age, Chicago, Ill.:

Gentlemen—Herewith you will find a newspaper clipping which will afford grounds for reflection among those interested in irrigation matters. Probably you have already seen the deliverance.

Is it possible, in view of all that has been accomplished in the direction of reclaiming the arid lands of the West and in view of the further fact that Mr. Newell's bureau has not up to this time reclaimed one acre of arid land, nor constructed a mile of irrigation canal conveying water, that these statements will be allowed to go unchallenged?

This "dog in the manger" policy has already injured a number of legitimate irrigation enterprises in this section of country and it is creating considerable prejudice against the Government and its noisy but ineffective irrigation bureau. To many of us the Government Reclamation Service begins to assume the aspect of a menace and an evil rather than a benefit. It threatens to overturn and disarrange all of our affairs and to blight our prospects, and we are beginning to regard the Government as an enemy rather than a benefactor.

Presuming you are interested in such matters, I have concluded to call your attention to Newell's attitude in this business.

Yours truly,

John T. Alterman.

MR. C. G. ROWLEY.

The editor of The Irrigation Age returned recently from a trip through Nebraska, Colorado, Wyoming, Utah and Idaho, where he looked into different irrigation projects both of a private and federal character. On this trip he was accompanied by Mr. Chas. G. Rowley, Chairman of the Committee on Arid Lands and Irrigation of the National Association of Implement and Vehicle Manufacturers of America. This association has a membership of several thousand, has $300,000,000 capital invested in manufacturing plants and the value of the finished product of the members of the association annually amounts to something like four hundred millions of dollars. It was with a view to giving Mr. Rowley an opportunity of looking into the possibilities of irrigation and the development of the West that brought about this trip and Mr. Rowley will furnish to his association at its next annual meeting, which is to be held in Chattanooga, Tenn., a report covering his investigations and suggest such a line of action to the association as will assist in extending irrigation development, both that carried on by private corporations and projects under the control of the Federal Government.

C. G. ROWLEY, Jackson, Mich.
Chairman of Committee on Arid Lands and Irrigation, National Association of Implement and Vehicle Manufacturers.

The association made a happy selection when Mr. Rowley was made chairman of this committee, as he is a very thorough man and immediately commenced to study the subject so that his report would be comprehensive and full. Mr. Rowley is still in the far West, but will return some time early in September, when he will begin work on his report. We are showing herwith a good likeness of the gentleman. Mr. Rowley is treasurer and general manager of the Aspinwall Manufacturing Co., the leading potato machinery manufacturing concern in the world.

LEADING IRRIGATION JOURNAL.

Under the heading "The Leading Irrigation Journal," The Oregon Irrigator of Irrigon, Oregon, has the following to say concerning The Irrigation Age:

"The Irrigation Age, published at 112 Dearborn street, Chicago, by the D. H. Anderson Company, stands at the head of the world's irrigation journals. It is a very handsome publication containing thirty-six pages, each 9x12 inches, is printed on fine paper and profusely and handsomely illustrated. In typographical and mechanical appearance it is a gem—one of those rare publications which one never likes to see soiled, torn apart or destroyed. Nearly every copy is saved as a souvenir.

"The The Age shows most resplendently from a literary standpoint, for in that respect it is one of the ablest class publications in this country. Mr. Anderson, the editor, is the foremost writer on irrigation in the United States, and he has each month in The Age numerous articles on pertinent subjects of great value to every irrigator.

"Every one of our readers should take The Age. Any person who is interested in irrigation, even though indirectly, and does not take it is making a mistake, which should be rectified by at once sending a dollar for a year's subscription. It will be the best dollar-investment you ever made."

THE TWIN FALLS IRRIGATION PROJECT OF IDAHO.

Information About This Giant Enterprise That Will Cost Its Promoters Over a Million Dollars.

A representative of THE IRRIGATION AGE spent a week's time in Idaho recently looking over different irrigation projects, among them the Twin Falls Land & Water Co.'s project along the Snake River. This is the largest private project ever undertaken in the United States, and the vast area under the Twin Falls canal is peculiarly favored for irrigation. It slopes gently to the west in such manner that it can be watered from the canal and laterals with no difficulty. The amount of land to be irrigated by this canal is about 240,000 acres. It is located in the Snake River valley in the vicinity of the world-famed Shoshone Falls, which are second only to Niagara Falls in importance and beauty. The land, also, surrounds the Twin Falls noted for their scenic grandeur and enchanting beauty, these falls being nearly as large as the Shoshone Falls. Near the lower part of the land to be irrigated are also to be found the Auger Falls, of no small significance. The soil under this canal is exceedingly rich and productive and contains no alkali or mineral substances injurious to vegetation. It is particularly free from gravel and stones. Idaho is known distinctively as a land of sunshine. It is noted for cloudless skies, and there are very few days in the year when the sun can not be seen. It is also noted for its healthfulness. The winters are comparatively mild, with but a moderate amount of snow, while the spring and fall seasons are usually delightful; sometimes the weather is warm in summer, the thermometer in the Snake River valley running up as high as 105 to 108 in the shade. This was the temperature during the writer's visit at Shoshone and the Twin Falls district, but he could hardly believe the statement made that it was over 105 in the shade, as it certainly did not seem to be over what would be known as 80-degree weather in Chicago. This peculiarity is due to the fact that there is so very little moisture in the atmosphere, and furthermore, a good breeze is always blowing from the mountains on the south or north.

Shoshone Falls, near Twin Falls City, Idaho.

Away to the north of this tract of land is what is known as the Saw Tooth range, a beautiful range of mountains, snow capped, which have the appearance of saw teeth, owing to their almost equal height and uniform size. This is really one of the prettiest mountain ranges in the country, the only possible objection to them from a scenic standpoint being the monotony in regard to height, one peak being apparently no higher than the others. This range extends from the extreme east looking north from Shoshone Falls to the end of vision to the west. Another mountainous country lies south of the Twin Falls tract. The State of Idaho has long been known as "the gem of the mountains," this title having been given it, no doubt, from the fact that large quantities of minerals were found in this State at an early date. That title holds good now that large areas of the State have been watered from the mountain streams and have been turned from sage brush plains and trackless areas into lovely farms and gardens.

Some of the finest irrigated ranches in the West are to be found in Idaho, this being particulary true of its fruit ranches, that State having become prominent as a fruit raiser within the past decade. The handiest way at present to reach the Twin Falls tract of land and the new town of Twin Falls City, is via Shoshone, a promising town on the Oregon Short Line railway, about 100 miles west of Pocatello. From this point a stage line may be taken as far as Blue Lakes and the famous Perrine ranch, which is located in the canon alongside of Snake River. From there another stage line is taken three or four miles further on to the town of Twin Falls City, which it is intended to make the metropolis of southern Idaho. Some very delightful scenery is found in making this stage trip, particularly west of Blue Lakes on the Perrine ranch.

Photo by Chas. E. Brooks, Pocatello, Idaho.

En route, Shoshone to Perrine's Ranch.

[The stage shown is an "old-timer," having been in service between Salt Lake City and Boise, Idaho, before the Oregon Short Line was built.]

Mr. I. B. Perrine, who is the vice-president and general manager of the Twin Falls Investment Co., a subsidiary company to the Twin Falls Land & Water Co., located at Blue Lakes eighteen or twenty years ago, and has developed a 1,000-acre ranch, which is noted as one of the best fruit and alfalfa ranches in the West. A peculiarity of this delightful spot is that the rim rock which makes the canon, forms a fence on one side of the ranch, while the green, rapidly flowing Snake River takes the place of a fence on the other side. Between this rim rock and the river may be found as finely developed fruit tracts as this country possesses. The writer spent a day or two with Mr. Perrine, driving over his ranch and later on over the Twin Falls land. Part of a day was spent at Twin Falls City. Mr. Perrine owns the ferry across Snake River at this point and has also built roads up the sides of the canon on to the table lands at a cost of many thousand dollars. The rim rock on each side of the river reaches up 700 to 900 feet at this point and it can be imagined that it was no easy matter to build a road from the base along the different ledges of rock until the table lands above were reached. The drive down into the canon and up out of it on the other side on the way to Twin Falls City will long be remembered by all who

A Fine Atmosphere—Snake River, Idaho.

have never experienced travel in the mountains or precipitous country. In fact one needs remarkably strong nerves to enjoy riding up or down over these roads for the first time. It was the writer's good fortune to be accompanied on this trip from Shoshone to Blue Lakes and over the Twin Falls land by Mr. G. D. Aiken of the Oregon Short Line and Mr. Charles E. Brooks, who is also connected with that company. Mr. Brooks had a camera with him and secured several photographs on the way, some of which are shown in connection with this article.

The lands under the canal system of Twin Falls

Clearing the Land of Sage Brush near Twin Falls, Idaho.

Land & Water Co. have been withdrawn from the public domain by application of the State Land Board under the provision of the Carey Act. By this act the United States Government will transfer title to the State, which in turn deeds control to the settler. Under strict regulations for the protection of settlers, the State has entered into contract with the Twin Falls Land &

Water Co., the latter agreeing to construct the canal system, which is nearly completed, secure settlers and otherwise improve the lands. Water used in irrigation of the land is diverted from the Snake River, twenty-three miles above Shoshone, and flows into the main

Photo by Chas. E. Brooks, Pocatello, Idaho.

Stage Going Down Into Canon at Blue Lakes [Perrine's Ranch].

canal in a westerly direction for a distance of sixty-nine miles. The main canal is eighty feet wide at the bottom and 120 feet wide at the top and will carry a volume of water ten feet in depth. In their irrigation the canals will require no flumes or side hill work and with the laterals will constitute a system requiring over 1,000 miles of excavation. The Snake River always carries an abundance of water and in this project nothing in the way of reservoirs is needed for storage purposes.

For the information of those who may contemplate investigating this project it may be well to say that in order to obtain title to land under the Twin Falls canal, purchase must first be made from the company of water right. The State then requires the sum of 50 cents per acre, one-half of this amount to be paid to the State when entry is made and the other half upon final proof and patent, any time within three years after notice that water is ready or on the land. This soil will produce wheat, oats, barley, rye, corn, corn wheat, kaffir corn and hops and the land is admirably adapted for beet sugar culture. Among the grasses which may be grown are alfalfa, clover, timothy, red top and orchard grass. Blue grass can also be successfully grown for pasture. Among the fruits which it is known can be raised successfully and profitably are apples, peaches, pears, prunes, plums, nectarines, apricots, cherries and quinces, as well as blackberries, raspberries, strawberries, etc.

It is our intention in later issues to publish a series of articles concerning the development of this giant project. Illustrations will be used, showing first the virgin land with sage brush. Others showing the land under the operation of the removal of the sage brush, as well as the land before it is plowed and after it is plowed and cultivated. It is our intention to illustrate fully the development of certain tracts under the Twin Falls project in a series of articles entitled, "The Story of An American Irrigated Farm," the object in publishing this serial story being to thoroughly familiarize people throughout the Central States, who have no knowledge of irrigation, with the amount of labor required, cost of land, cost of producing crops after the land is cleared and broken, cost of water, its distribution, maintenance of canal system and then the value of each crop harvested, with a full explanation of methods of procedure of planting, cultivation and eventual sale of crop, with comparative figures as to prices received in Idaho and other points throughout the West. It can readily be seen that a series of articles of this character will prove valuable, not only to those interested and engaged in irrigation farming in other sections throughout the West, but will be particularly advantageous to those contemplating purchase of land and farming under irrigation. THE IRRIGATION AGE will have a representative on this tract, who will regularly prepare articles for its columns.

Photo by Chas. E. Brooks, Pocatello, Idaho.

Trout Stream at Perrine's Ranch.

The Oregon Short Line Railway had a survey made through the Twin Falls irrigation tract and it is said before very many months roll away trains will be running into Twin Falls City and beyond. This will do away with the stage trip of something like thirty miles, which is now necessary to reach the site of the new town. Large numbers of land buyers are looking over this tract regularly and entries are being made.

THE PRIMER OF IRRIGATION.

CHAPTER XVII.

QUANTITY OF WATER TO RAISE CROPS.

(The Duty of Water.)

The amount of transpiration through the leaves of plants will furnish an approximation of the quantity of water needed by them before they can attain perfect maturity. That amount of water in the shape of moisture they must have, and if they can not obtain it by natural means, through rainfall, ground water, capillary action, dew, or moisture from the atmosphere, it must be supplied by artificial means through irrigation, else the farmer may as well retire from business, unless he admires a useless expenditure of labor year after year.

It is alleged by men of the highest scientific standing, men who have made irrigation agriculture a profound study, and have performed a multitude of practical experiments to demonstrate the verity of their proposition that about forty inches of water whether rainfall, or evenly distributed artificially, is the proper and essential quantity to successfully grow a crop from the planting to the harvest. Some claim that a lesser quantity will be sufficient. Thus, Professor King found that he could use 34 inches for the growing season in Wisconsin. In California from 7½ to 20 inches will answer the purpose; in Colorado, 22 inches; in India 48 inches are necessary, and 50 inches in France and Italy. All these calculations are based upon the quantity required per acre during the growing period of a crop, which is estimated at about 80 or 90 days.

Ben Davis Apples, Perrine's Ranch.

It is well for the reader to grasp the immensity of such volumes of water, and to enable him to do so, a few mathematical facts will not be out of place.

One inch of water covering an acre of ground, equals 27,154 gallons, or 1,086,160 gallons per acre for the season upon the basis of a supposed total of forty inches. The weight of this amount of water at 8 1-3 pounds standard U. S. weight to the gallon, is nearly 4,526 tons. Weight will be used instead of measure in order to make comparisons.

Let us take potatoes as an illustration, and on them base a simple calculation. According to the laws of most of the States, a bushel of potatoes weighs sixty pounds avoirdupois. At the rate of three hundred bushels per acre, which is a very large yield to the acre, the weight will reach 18,000 pounds, or nine tons.

In the case of sugar beets, the production runs all the way from fifteen to thirty-five tons per acre.

Now, it has been calculated that potatoes and beets contain from 80 to 90 per cent of their weight in water, or its equivalent, and at 90 per cent, to give them the benefit of the largest possible quantity of fluidity, an acre of potatoes would contain about 8½ tons of water, and an acre of beets about 32 tons.

It is impossible to believe that this small quantity of vegetable extract required the distillation in the plant of 4,526 tons of water in ninety days, and the fact is that it does not. In a former chapter it is said that moisture, or water in the shape of moisture, is taken into the plant by way of the roots, and after being utilized in the economy of the plant, it is discharged

through the medium of the leaves; that is to say, transpired through the stomata or mouths of the leaves. Indeed, there is no other way by which water can enter into the plant. It is a solvent for plant food, and the plant having absorbed the food, rejects the water by transpiration.

The reader will find in Chapter V an experiment made by Professor Williams of Vermont with an acre of forest containing 640 trees averaging 8½ inches in diameter and 30 feet in height, having an average of 21,192 leaves on each tree to transpire water during ninety-two days.

It was discovered by careful experiment that such an acreage of trees drew from the soil and evaporated, or transpired by way of the tree leaves, 2,852,000 pounds of water during ninety-two days, or 1,426 tons, the evaporation or transpiration being calculated as going

View in Perrine's Vineyard, Showing Loaded Grape Vines. Mr. I. B. Perrine is central figure in group. The figure to left is Mr. G. D. Aikin of the Oregon Short Line Railway.

on twelve hours per day, inasmuch as it is almost imperceptible at night. This leaves a very large balance of the 4,526 tons unconsumed by the trees, and even assuming that the leaves transpired water during twenty-four hours there would still be 1,674 tons to the good unutilized by vegetation.

Carrying the calculation still further, let it be assumed that the evaporation from the soil was 1,000 pounds per hour and that such evaporation occurred every hour of the twenty-four, and there would be still remaining unutilized for any known purpose 570 tons of water. There would remain a much larger quantity, for the estimate of evaporation could not exist in a forest, and not under any circumstances at night. Moreover, evaporation from a freshly plowed soil does not reach 1,000 pounds per hour, even without vegetation to retard it.

Recurring to the sunflower experiment (Chapter V). An acre of sunflowers three and a half feet high, estimating 10,000 of them to the acre, which would be crowding them, with their great broad leaves, would transpire during twelve hours every day for ninety days 810 tons of water drawn from the soil. It will be perceived that the 4,526 tons of irrigating water or rainfall are still practically intact, and it may occur to the mind of the ordinary reader that forty inches is altogether too much water to put on or into the soil for any profitable or needed purpose. If not, what becomes of it? It is not utilized by vegetation of any sort. Even sugar cane, which possesses an insatiable thirst, would repudiate such gluttony.

The fact is, about three-fourths of this water is wasted—fed to run-off, seepage and drainage. It is put into the soil to kill the plants eventually instead of nourishing and giving them life.

Government experts say that out of a possible forty inches of rainfall 50 per cent of it is lost in running off or out of the land, and 25 per cent disappears through evaporation. If this is correct, then there are left ten inches to be utilized by the crop, whatever it may be, and according to our calculation that amount is ample for plant growth from the planting to the harvest if irrigation is practiced as it should be.

There is this to be also considered, that rainfall does not mean a precipitation of a certain number of inches of water during the growing season when needed more than at any other time, whereas irrigation does mean that very thing. Taking four months of the year as the growing period, that is to say, May, June, July and August, where summer is the seedtime and harvest, or January, February, March and April on the Pacific Coast and semi-tropical regions, the mean monthly precipitation of water at forty inches per annum would be one-twelfth of the annual supply, or three and one-third inches, a total for the entire growing period of thirteen and one-third inches.

When it comes to crop requirements averages are to be disregarded, but assuming it to be true that the forty inches of rainfall are evenly distributed during the growing season, as above specified, then a crop can be grown to maturity on thirteen and one-third inches; indeed, it can not be imagined that the entire annual rainfall is precipitated upon the soil during the four months specified unless rice culture be contemplated. With thirteen and one-third inches of water distributed through the growing season the soil receives 1,508 tons of water per acre, which, by referring to the cases of the forest and the sunflowers above given, will more than satisfy the requirements of those plants; in fact, nearly two acres of sunflowers can be amply provided for.

Now, what becomes of the remaining twenty-six and two-thirds inches of the assumed forty inches? The 3,018 tons of water on our acre? In the opinion of the writer that water has gone down to raise the ground water uncomfortably close to the root zone, where it will do damage, has run off or drained off. It is certainly wasted unless the excess is intended to irrigate several more acres further down some slope, or is to be pumped out from wells and used over again. In that case, why put so much water on the soil if agriculture be the object and not the water supply business?

It is not safe, however, to rely upon thirteen and one-third inches of rainfall during the growing season. Farmers know to their cost that then the rain possesses a very retiring disposition, and the skies are brazen for long periods, long enough, sometimes, to either ruin the crops or to stunt them and produce only a small percentage of what was expected from their early start and growth. In other words, the growing season is also the season of drouths, except in those regions where winter is the growing season, there being no frosts to retard vegetation. Yet, strange to say, even with all the uncertainties of summer moisture good crops are sometimes grown and that on a small percentage of the annual rainfall. With irrigation supplying the deficiency of rainfall there is a certainty of a good, profitable crop every year.

What has been said thus far relates to land which contains natural moisture or a water table, a supply of water which is brought up to the surface by capillary action or by accretions from heavy rains, and where the soil is wet enough to require a system of drainage to carry off the surplus. It is easy to perceive that under such conditions plants will draw moisture from below by means of their tap roots and thus supply themselves with plant food to make up for any deficiency of precipitation. Where those conditions prevail, irrigation becomes supplemental and is not only useful but essential in the humid regions to overcome the possible damage likely to occur during the period of drouths. To dose the soil with water having a water table near enough the surface for the tap roots of plants to reach would be a waste and of no benefit to plant life, as will be readily believed when it is understood that too much water is as detrimental to plant life as too little.

Where there is moisture in the subsoil, and even a modicum of rainfall during the summer months, the author would suggest that if the deficiency amounts to six inches, or four inches, or thirteen inches, such deficiency be made good by an artificial application of water at regular intervals, one surely just at the period of flowering and the last one just before the ripening of the fruit, or at the period when they are said to be "in the milk." At that time a chemical transformation is taking place in the economy of the plant, and it must be supplied with the material to continue it, else it will shrivel and die of old age before ripening.

The same observations may be adapted to those semi-arid regions where the frosts of winter prevent the existence of plant life, and the rainless summers demand irrigation as necessary to raise a crop of any kind. There are fall rains and winter snows, and by keeping the ground open to their reception the moisture can be retained for a long enough period to start the infant plant well on its way in the spring, but after the first true leaves are formed irrigation must begin and continue during the growing period, for there is no rainfall to be depended upon as an aid to agriculture. Under such conditions plants do not require any more moisture than in any other region, and hence it is stated as a broad proposition that the same quantity of moisture that will raise a crop in the humid regions will also raise one in the semi-arid districts, where winter is a bar to winter growth.

In what are designated as "arid and semi-arid" regions, with a semi-tropical climate, although there is very little rainfall, it is surprising how far the small precipitation will go toward maturing a crop without the assistance of artificial applications of water. Five inches will raise a crop planted in dry ground before the rains come, and by careful and continual cultivation of the ground that crop will be profitable enough to make it worth while to plant. In favorable soil one inch of water will wet the ground down about eighteen inches or two feet, and the first rain penetrating to the seed that has been plowed under "dry" will cause it to sprout within three or four days. From that time on until the crop matures, in March or April, if the rain begins in December or January, the farmer cultivates plants that can be cultivated and harrows his wheat and barley to keep the soil open as much as possible. There may not be any moisture in the subsoil—on the contrary it may be as "dry as a bone" for a hundred feet down—but the crop grows, and with few inches of rain it reaches maturity. Of course, it is not luxuriant vegetation, nor is the wheat and barley as high as a man's head. But it produces enough for his stock and his vegetables, unless sugar beets and deep-rooting plants furnish him with a good supply. Some of these "dry farmers" say they are satisfied with eight inches of rainfall and consider fourteen inches a "wash out." In such regions the summer months, from May to November, and sometimes into December, the skies are cloudless and not a particle of rain falls. Then irrigation is an absolute necessity, and it is practiced so as to continue the growing season all the year round and to produce a succession of crops without any cessation. There is undoubtedly more evaporation from the soil than in the humid regions, but that is diminished by deep cultivation and pulverization of the soil. Plants, however, do not require any more moisture than in any other region, and when the quantity consumed by the plant during its period of growth is carefully gauged that is the amount of water to give the soil, with about 25 per cent added to the account of evaporation.

After all is said the quantity of water to be given the soil artificially is governed, in a great measure, by the nature of the soil. In Chapter V, "Relations of Water to the Soil," this subject is treated and the reader is referred to that chapter for the facts and figures. There is one axiomatic proposition which is here repeated in this connection because it is the key to the whole matter: "The more water the soil contains in its pores the greater the evaporation." Plants are like the human body—gorge it, even with the most nourishing foods, and it becomes sick; give it too little to keep up its system and it becomes anæmic. With just enough, an equilibrium is maintained and health is secured as a matter of course. This idea is what the author seeks to convey in calling attention to the fact that what a plant needs is the amount of provision to make for it; all beyond that is superfluous, a waste of material, not productive of any beneficial results.

IDAHO, THE GEM MOUNTAIN STATE.

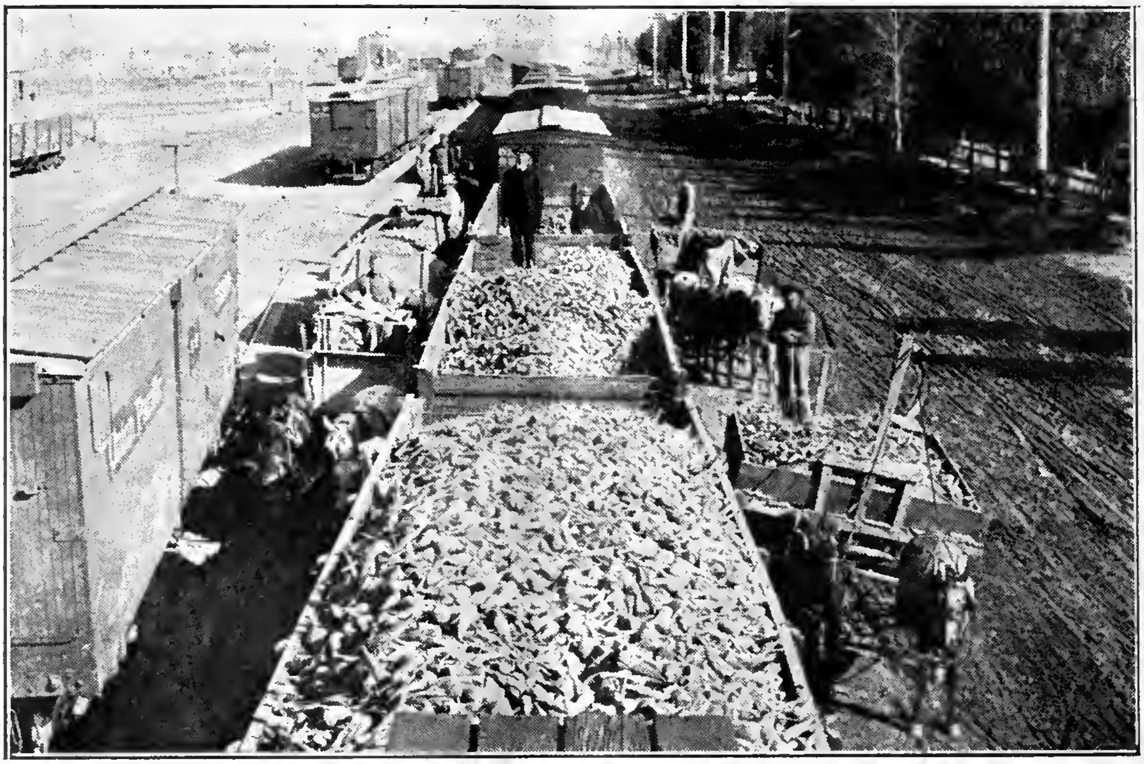
The American Falls Power, Light & Water Company and the American Falls Canal & Power Company, Two Large Irrigation Projects.

E. W. HART.

THE UPPER SNAKE RIVER VALLEY.

Whatever may be said of the uncertainty attending upon the investment of money in mining operations, the comparatively virgin State of Idaho has already yielded repeated demonstrations of the substantial returns which can be realized from a small outlay of capital in the cultivation of irrigated farms. The husbandman in the Eastern States, weighed down by the burden of the mortgage and never free from the accidents of drouth, hot winds and inopportune storms, knows of some one of his neighbors who has realized what he could on his incumbered estate, gone to Idaho and is reaping annually increasing reward for every month of toil and thrift bestowed upon a faithful soil. He who has not seized the opportunity himself, and whose means will not afford the necessary start in life for his sons in the midst of like conditions, is rejoiced to learn that they have solved the problem in the arid West to their entire satisfaction. This country no longer stands in need of a recommendation with the people—as witness the 106,000 applications which awaited the opening of the Rosebud reservation—more than fifteen times as many as could possibly be accommodated.

At the same time it is well to note in passing that the mineral deposits in this State undoubtedly reserve untold wealth for the future—a legacy which will devolve upon this young empire when it reaches its majority. Idaho has given the world $250,000,000 in gold and silver since their discovery in 1863. Its lead mines are among the richest in the world, producing over 55 per cent of the lead in the United States. It has extensive deposits of copper and coal. In Owyhee County are some of the finest opal fields in the United States and rubies are found in Latah County. In fact, the mining industry is represented in almost every county in the State, and is still in its infancy. The Thunder Mountain district, once almost inacessible, is slowly but surely taking rank as a steady gold-producing camp. A company is already in the field building for the future of this district, ready with power, electricity and enterprise to meet every progressive demand—the Twentieth Century Mining & Power Company, Ltd., with headquarters at Cleveland, Ohio.



Loading Beets for The Idado Beet Sugar Company's Factory, Idaho Falls.

Although the tiller of the soil may not always be willing to risk his hard-earned dollars in the mining industry, if he contemplates farming in this section he is, nevertheless, very much interested in the proximity of the mining camp. There is a growing market for farm produce in the camps throughout Idaho, and there are no better buyers than the miners; nowhere else are prices so high.

One hundred and sixty acres was once considered an ordinary farm in Idaho, but since the completion of the Idaho Beet Sugar Company's $1,000,000 factory during the past year at Idaho Falls the farmer in this section is growing rich from the products of a 20-acre field of sugar beets. This company has already paid the farmers over $500,000 for their beets; has paid out as much as $75,000 per month in wages, and has a capacity of 12,000 to 16,000 bags of sugar per day of 100 pounds each. It also creates a new market for the hay which is used in its processes of manufacture. Sugar beets yield the farmer from $80 to $100 per acre. They find the soil in this valley best adapted to their growth and are not injured by early frosts.

The reader should bear in mind that Idaho is still an undeveloped region—not without some myste-

rious features—appreciated, perhaps, later than her sister States, very largely, no doubt, because Nature has here disguised her most precious gifts with befitting modesty and prudence. Idaho is the best watered State in the arid West. The Snake River conforms in the most accommodating manner to the wants of the irrigator, coiling its thousand miles of length through as much territory as possible. The stream carries enough water each season to cover its entire valley of 5,000,000 acres over seventy-six inches. In some places this wonderful river is unfathomable—at one point, in fact, sounding to a depth of 240 feet failed to find bottom. As a contrast to the indefatigable Snake, Idaho has in the Lost River a mystery yet unsolved—a torrent swallowed outright, hustled suddenly down into the bowels of the earth, as if Nature's generosity in her watering operations had suddenly taken fright and collapsed.

Snake River valley, all begemmed with the glittering splendor of electrical illumination, and humming with the wheels of progress.

Pocatello, Blackfoot, Idaho Falls, Rexburg and St. Anthony are among the more important towns which have grown up in this region, counting populations of from two to six thousand—all prosperous, growing communities, everyone of them administered with a zealous regard to the best civic ideals. Idaho ranks high in her educational institutions. There is not a town in this locality which can not point with pride to its public schools.

THE AMERICAN FALLS POWER, LIGHT AND WATER COMPANY, LTD.

This company is one of the most advanced of Mr. Brady's several enterprises. It had its inception in the undertaking to furnish the City of Pocatello with cheap electric light and power, the rate now obtaining

Headgate, Great Feeder Canal.

Idaho is unique because it is a region of volcanic origin. Its mineral treasures have been locked up for ages under a combination which excites interest and is inviting investigation. In the meantime the sage plains are clearing and drawing water, the valleys here and there are blossoming into green and golden harvests and glistening with handsome orchards. And still there is unlimited water and free land for all.

But to return to the Snake River. While ample provision was made for the supply of water, the most modern demands of the settlers were not overlooked in the economy of this admirable watercourse, although this serviceable quality was quite effectively disguised behind a fair exterior. The innumerable tourists who have admired the Shoshone Falls on the Snake River have compared them favorably with the great Niagara. The Salmon Falls and Twin Falls are not less interesting to the traveler. The sightseer witnessed the scene and passed on well pleased. It was not until Mr. J. H. Brady came upon the ground and located at Pocatello that this enormous energy, harmlessly awaiting control was called into life, and the mysterious Spirit which the Indian legend assigns to the Snake River commenced to sing a new song, and tossing her cornucopia, strewed a string of smart towns along the upper

there for the same being, in fact, much lower than the average in other cities. This problem Mr. Brady proposed to solve by harnessing the power disengaged by the great American Falls. Apparently insurmountable obstacles attended the undertaking from the start. The only sites for the erection of a plant on either bank of the river were already guarded by other claimants. Nothing daunted, the Brady forces did not hault then, nor at any time, until victory had crowned their efforts. Ignoring the riparian claimants, a jutting rock in the middle of the falls was deemed good enough with such enterprise behind the project; a foundation was blasted out of the solid rock, a thousand horsepower plant at once installed. and at an outlay of $350,000 the cities of Pocatello and Blackfoot (the latter at a distance of fifty miles from American Falls) are at the present time supplied with excellent light and electric power by this company. Improvements are now in progress to increase the capacity of the plant to 6,000 horse power. The total energy to be derived from the American Falls is estimated at 40,000 horse power, all of which this company proposes to utilize eventually. With this pressure at command, and a line of high tension wire connecting the Power City with Idaho Falls and St. Anthony, the enterprise will rejoice

in its full consummation, and the thriving communities of the upper Snake River will lack nothing of the luxuries of the day.

This is only one instance of what J. H. Brady is doing for Idaho. His presence in that State is a matter of "mutual congratulation to both parties." Mr. Brady predicts a great future for Idaho and it is needless to say that the State is proud of its prominent citizen.

THE AMERICAN FALLS CANAL AND POWER COMPANY.

This company, of which Messrs. Utley and Jones of Blackfoot are the local representatives, is reclaiming a vast area of sage plain, extending sixty miles along the west side of the Snake River from Blackfoot to American Falls, and having an average width of six to eight miles. This gently sloping broad stretch of land is here awaiting the water which this company's canal is bringing nearer, drawing its perennial supply from the Snake River about ten miles above Blackfoot. The prospect is a good one for the homeseeker, and there is still plenty of room. The soil is a rich sandy loam, from four to twenty feet in depth. The locality is only about twelve miles northwest of Pocatello, and is penetrated at two points by the Oregon Short Line.

If, by the way, the Short Line is extended from St. Anthony into Yellowstone Park, as the maneuvers in that region seem to indicate will be done, it will open up another considerable market for this immediate region—a market which has heretofore been monopolized by Minnesota. The home market has been already mentioned. This valley also lies in the direct path between Utah and Montana, both of which States afford good markets for Idaho produce in their mining communities. The grazing interests, one of the most important industries in Idaho, are a never failing source of income to the strictly field farmer. More will be said about the eastern market for Idaho fruit, the finest in the country.

The system of the American Falls Canal and Power Company is under the Carey Act—the company a contractor with the State to furnish the capital and to build the canals, for which outlay and investment its remuneration is fixed by the contract, in the sale of the entire system, when installed, to the settlers in shares—one share giving the title to water sufficient to irrigate one acre of land. The price per share is fifteen dollars, subject to change, however, as to future buyers, as the amount of expenditure becomes more definite as the work proceeds, but only by the action of the State. Payments may be made in installments. Having bargained for this water, the farmer buys the land from the State itself, paying fifty cents per acre, half in cash and the remainder when patent issues. A farm of thirty to fifty acres soon pays for itself, nor is a large amount of cash required to get a start. After that, with thrift and good management, failure is impossible. A crop can be raised the first year. On the other side of the river and for miles up and down the valley, the fields are yielding their three crops of alfalfa, with six to eight tons to the acre, spring and fall wheat, thirty bushels to the acre, barley, rye, oats, are extensively grown. Cantaloupes, sugar beets and all kinds of vegetables flourish. Cabbages and onions are especially good, and the potatoes are considered even superior to the famous Greely tubers. A good and reliable income is derived from these products from the start, and in the meantime the thrifty farmer is carefully training a fine orchard, which in the course of four or five years will begin to bring him wealth and luxury. Idaho is a successful rival to California in her fruit products, with a large traffic to Chicago, New York and other eastern cities. She received the World's Fair award for apples in 1892, to say nothing of a long list of other prizes, including the $500 sweep-stake cup offered by U. S. Senator Wm. A. Clark at the Irrigation Congress at Ogden last year, for "the greatest variety of perfect fruit, free from insect pests and fungus diseases."

About sixty miles northwest of this tract of land just described, the Lost Rivers, which have already been mentioned, have their place of disappearance. Whatever may be their course below the surface, it is a fact that wells sunk anywhere upon this section never fail to tap pure, cold water at from 15 to 60 feet in depth, and in several places the water gushes forth in flowing springs.

IDAHO CANAL & IMPROVEMENT COMPANY, LTD.

While this land is now lying open for settlement, just beyond and extending on up the valley, are to be seen hundreds of well cultivated, prosperous farms, and well settled districts. Much of this land lies under the lateral ditches of the Idaho Canal & Improvement Company, a private enterprise launched by J. H. Brady, and of late years attained to a fullness of usefulness. Some two or three hundred irrigators take from this canal at the company's present rates, while a year ago a great portion of its system was purchased from the company by the water users contributing to it then, and now the cooperative owners—the usual disposition made of a private irrigation company in Idaho as soon as it is able to pay for itself.

This company has a tremendous mileage of main canals and laterals in Fremont, Bingham and Bannock counties. It has three head-gates on the Snake River. No. 1 is located on the South Fork of the Snake in Fremont County, where that river leaves the mountains and enters the valley. This company also owns an interest in the Great Feeder Canal, into which the water is diverted through a solid masonry headgate, with a system of diverting gates, each ten feet wide, permitting a flow of water to enter the Feeder Canal one hundred feet wide and five feet deep. About four miles below this point the Idaho company diverts 30,000 miners' inches of water through its own private headgate. Its gate No. 2 is one of the largest in the valley, taking its supply from the main river about fifteen miles below the junction of the North and South Forks; 50,000 miners' inches of water can be diverted at this point. At the Reservation gate, No. 3, water is diverted capable of watering a large area between Basalt and the Blackfoot River besides furnishing sufficient water for the use of the Indians on the Fort Hall Reservation and to the fertile lands north of Pocatello.

On the 6th day of September, the remainder of the Fort Hall Reservation will be thrown open for settlement, containing about fifteen square miles of irrigable land. This company will extend its canal a distance of twelve miles from the north, to water this region, having commenced surveys for this purpose. A further extension will be made to Pocatello. The main channel, now carrying 15,000 inches, will be enlarged from its head on the Blackfoot, and will be capable of delivering altogether 40,000 inches of water to the territory above described.

TWELFTH NATIONAL IRRIGATION CONGRESS.

Full Scope and Meaning of the Great November Meeting Explained by an Editorial Writer Who Favors the Construction of an Enormous Reservoir in Western Texas.

El Paso, Tex., August 31.—Under the caption, "El Paso's Greatest Opportunity," the *Morning Times* publishes the following editorial concerning the scope of the Irrigation Congress:

"If the people of El Paso do not fully appreciate the extreme importance of the National Irrigation Congress to be held in this city, November 15-18 next, it is high time for them to carefully study the full scope of the convention and the meaning it carries with it, for it presents the only opportunity that is within reach of our city for it to receive a direct and valuable indorsement of its international dam—a project which means, to state the case in a few words, that the more powerful Government of the United States should do full justice to the weaker Government of Mexico in the distribution and use of the waters of the Rio Grande.

"As the case now stands the flow of the river is exhausted by irrigation methods in Colorado and New Mexico long before the descending waters reach the El Paso Valley and the Mexican frontier, until the farmers here on both sides of the border have seen their lands scorched by drouth and themselves impoverished to the point of demanding relief.

"Indeed, we are wrongfully deprived of the usage of the waters of the river, for at various times in many parts of the Union where interstate questions involving the use of water for irrigation purposes have arisen the courts have invariably awarded to the first users the privilege and right of ownership to waters by reason of priority of usage, commonly known under the Spanish law as the first riparian right.

"But, beyond and outside of that consideration, the Irrigation Congress has the expenditure of a fund of $27,000,000, derived from the sale of public lands, which is to be divided among only sixteen States and Territories, in which Texas, unfortunately, is not included, because she owns her own lands, over which the Government exercises no control. Inasmuch, therefore, as the State of Texas does not contribute by the sale of public lands to the reclamation fund, she can not, of course, participate in the benefits to accrue from the expenditure of the large sum of money in the arid regions and must depend solely on special legislation for an appropriation to be used in the construction of the international reservoir near the city; but to obtain such legislation an indorsement of the National Irrigation Congress will be found of great value.

"The position occupied by El Paso is unique and has no parallel on any frontier of our country. To the north the Canadian border has constant and copious rainfalls and needs no irrigation; to the south there is no point on the frontier as early settled as the El Paso Valley, whose inhabitants were the first users of the waters of the Rio Grande for irrigation purposes, and below the El Paso Valley there is either no land suitable for irrigation or else there is an abundant flow of water the year round, beyond where the tributary streams like the Rio Concho empty into the main channel.

"It is, therefore, a unique situation for both governments, with a unique opportunity presented to both, and the United States will doubtless avail itself of the privilege now offered of doing full justice to Mexico and of giving us the grandest object lesson of irrigation that could possibly be attempted.

"While an international dam thus constructed would prove of incalculable value to this entire section, there is yet another peculiar benefit to be derived from the Irrigation Congress which assembles in this city in November. It is this: We are in the midst of a mining region and are surrounded by miners on every side, so that we are more than repeating the history of the magnificent growth of Denver. For wherever there have been deep mines and deep mining in this section they have been most productive of wealth and in every instance El Paso has been connected with such mines by means of railroads. Now it happens that the arid States are the identical States which comprise the mining region of the country, and while it is difficult to bring real mining men to a miners' congress, because there is no money to divide, yet we can be sure that mining magnates and mine operators will flock to the Irrigation Congress because there are $27,000,000 of federal money to be divided and expended in the arid regions. Furthermore, the treasury will be replenished by every acre benefited, making the irrigation fund permanent and constantly increasing.

"If, therefore, the Irrigation Congress can bring together the miners of the West and of the mountain regions, which are identical with the arid regions, this, then, is El Paso's greatest opportunity, and the city would deny itself ten years of its growth and the county would be guilty of the same mistake if each did not liberally appropraite moneys for this great November event.

"Last year, when the El Paso delegation went to Ogden, it was not until the last moment that the enormity of the importance of the Irrigation Congress made itself manifest to those in charge of the movement. Even the State of Utah appropriated $5,000 for Ogden's benefit in the reception and entertainment of that grand gathering, and there were above $10,000 subscribed and paid to the same fund by private individuals of less important points throughout the State, but the congress was worth all the money expended.

"Now the State of Texas is peculiarly situated in this respect, for the constitution forbids the appropriation of a single cent for enterprises of this character, and even the Texas building at the World's Fair was created by private subscription. El Paso, therefore, must depend solely upon her own resources to make the November congress a brilliant success, and the city and county authorities, who have been called upon for assistance, should not respond with any halfway dickering, but should come forward and contribute the full amount which they have been asked to appropriate."

PROBLEMS IN THE IRRIGATION LAWS.

The following is taken from the Denver *Daily Republican* of August 8th:

"Two questions of the utmost importance have arisen in regard to the enormous irrigation enterprises being started under the reclamation bureau of the Federal Government. Both involve the provisions of the law itself. One of these is whether or not it would be best for an independent commission to place and direct the various enterprises. The other is the question of what conditions will prevail when the purchaser of land obtains full title."

D. H. Anderson, publisher of THE IRRIGATIION AGE, of Chicago, raised these points in a discussion at the Oxford Hotel last night. With Mr. Anderson were C. M. Shultz, of the Associated Farm Press, comprising fifty daily papers, and C. G. Rowley, of Jackson, Miss., chairman of the committee on arid lands and irrigation of the National Association of Implement and Vehicle Manufacturers. All are interested in irrigation and are in the West to obtain information.

"It is claimed by many," continued Mr. Anderson, "that the law should be changed to provide for the selection of a commission of men of the highest standing and representing all sections of the country; this commission to select the places where reservoirs shall be constructed. At present this is all done by the reclamation bureau, which is a part of the Interior Department.

"Many claim that the present system permits of the establishing of these great Government enterprises in such a manner that corporations or individuals are benefited. It is asserted that this was the case in Arizona, that there a reservoir project that would have reclaimed 350,000 acres of the public domain was abandoned in favor of an irrigation system that will reclaim 200,000 acres of land owned by private parties.

"This is considered a very dangerous condition by many men interested in irrigation. These maintain that the law should be so amended that there could not be any chance for such results. A commission, composed of men of recognized integrity, is believed to be the best means of accomplishing this.

"In the eliminating of what might be called all chance for graft, another good result could be accomplished, it is maintained. This would consist in the selection of reservoir sites in such a manner that the best results would be obtained and the systems prove valuable for all time. By these methods it is believed the best possible results could be accomplished.

"Probably more important than these points is the question of the conditions that will exist in the future, when the farmer owns the land the Government has reclaimed. This question, which involves the operations of federal and State laws, especially with reference to the bearing one has upon the other, will be up to every farmer some day unless a change is made now. At least that is my opinion.

"The individual who takes up Government land, with the water privileges accorded by the national irrigation law, is bound to conform to the government of the federal authorities until he has acquired an absolute title to the land, and then he becomes subject to the State sovereignty, the federal authorities having no further dominion over him or his land or to control the water.

"All federal laws shall be of uniform, general application or operation, however special they may be in their intent. Now, if the federal law is made general it is bound to result in a contract with the buyer of land in some State where there is a conflict with the State law. But the buyer holds a title, clear, and the Government has nothing more to do with him. He is under the State laws. If his contract conflicts with these, where will the controversy be adjusted?

"To attempt to make a federal law that will conform with the laws of all the States in which it operates is impossible now. Some means should be found to adjust these matters. Some body of men should be legalized to bring about uniformity in the irrigation systems before the effects of the present system are felt. Such a body of men should be representative of the persons directly concerned. The system that should be adopted should make it possible for every man in every State to receive his water right in the same legal manner.

"Colorado is the very heart of the irrigation movement, both federal and by private capital. The State has before it a wonderful future. With the development of agriculture, even to its present state, Colorado is beyond any disturbance of any kind that can give it a permanent setback."

Mr. Rowley is in the West to obtain information for a special report that he will submit to the implement manufacturers at their next annual meeting in Chattanooga. This report will cover the irrigation question thoroughly. It will be the basis of bringing the support of the association, which has invested in plants $300,000,000, to the reclamation work from the standpoint of business. With its influence gained, one step will have been taken in educating the Eastern people to the benefits of building up the West.

IOWA DRAINAGE ASSOCIATION.

The delegates present at the recent State Drainage Convention held at the Agricultural College organized the Iowa Drainage Association. The association was formed by men who realize the urgent necessity for state-wide organized effort in behalf of new drainage laws which will adequately meet the needs of this State. The members of this association propose to unite in support of the drainage bill which will soon be drafted and presented to the legislature by the strong legislative committee which was appointed by the chairman of the Drainage Convention.

Every owner of wet land in Iowa appreciates the urgent need for a new drainage law; he also knows that such a law will not be passed unless he unites with his neighbors and asks for and works for such a law. Without a doubt every man's efforts will count for the most if he will identify himself with the recently organized Drainage Association. Iowa's need is great and therefore we do not hesitate to urge the land owners of the State to join the association and thus aid in solving this important problem of drainage legislation.

The membership fee is one dollar, which entitles the member to a printed copy of the full proceedings of the Drainage Convention. These reports, as soon as five cents per copy. Applications for membership or for the reports of the convention should be addressed to Prof. W. H. Stevenson, Agricultural College, Ames, Iowa, secretary-treasurer of the Drainage Association.

BROUGHT BY THE POSTMAN.

Letters From Correspondents to The Irrigation Age.

Peoria, Ill., Aug. 13, 1904.

D. H. Anderson,
Editor The Irrigation Age, Chicago, Ill.

Dear Sir: Please allow me to contribute a few lines upon the most important subject, irrigation, of which so much has been said over and over again since the beginning of ancient history, all efforts having failed to improve our irrigating system thus far. Many of us can remember forty or fifty years ago when corn rows were laid off with a plow and dropped by hand. Wheat also was cut by a cradle and the same was tramped or flailed out. Also stage coaches were our modern conveyances and hundreds of other things might be compared with today. One can hardly realize that such a difference is possible, yet it is true. All along the line these changes have been taking place during these years.

How about our modern irrigation as compared with fifty years ago, yes, say over two thousand years ago, where the Bible speaks of the flooding and furrow system used in Egypt by Pharaoh's people? With experiment stations in every State and territory with ample funds to carry on such work as they may desire toward the improvement of our irrigating system, and in charge of men some of whom have made a life study of irrigation—with all this equipment in the hands of our most learned men along this line, we fail to deviate from the old way of irrigating of two thousand years ago. Just as much water evaporates now as did then, only we are worse off in regard to water than they were. While they had plenty without pay, we have to depend upon some water trust at high price to furnish water.

In many parts of our country water is a very valuable article. This being the case, why feed the sun fifty to seventy-five per cent of the moisture when it can be saved by sub-irrigation. Roots of whatever nature will always grow toward moisture, the moisture being on top. By the flooding or furrow system, naturally the roots will grow to the surface. It being very necessary to plow the ground, or it will bake and get hard, many roots are cut or torn from their hiding places and thereby the health of the tree is impaired and to a great extent, like an unhealthy man, breeds disease. This being the case, the fruit is very largely affected both in quantity and quality. The top being so wet, with the aid of the sun, draws the alkali to the surface, which is injurious to both soil and plant. In my estimation, the system which gives the best results from the least amount of water, labor and expense in the system that should be used. I think sub-irrigation comes nearer fulfilling all these requirements than any other system. By sub-irrigation one is not dependent upon some water trust for water, but has his own system and is independent, which means a great deal to him. By having the system under pressure, one can irrigate uneven as well as level land and place every drop of water where it is most needed. Roots of trees grow deeper and make healthy trees, less liable to disease, and bearing more and better fruit. This saves plowing, as the ground does not bake and get hard; saves fifty to seventy-five per cent of moisture and same per cent in labor. And last, but not least, such a system, if properly constructed, would be self draining. There are times during the year when the soil is too wet, either from rains or otherwise, and in such case it can be drained off in a short time.

Yours truly,
W. A. Lee.

Seistan Arbitration Commission via
Quetta, Baluchistan, June 25, 1904.

The Irrigation Age, Chicago.

Dear Sirs: I send you the second of exchange of a bill for $3.00 that was sent you some time ago as my subscription to The Irrigation Age. I am much obliged to you for sending me The Age steadily, as it is very difficult to remit from here and I am afraid the way this bank has done, it will take a long time to reach you. When it does I hope you will send me a copy of the Irrigation Primer, as it is the best work of its kind I have seen and invaluable to people interested in irrigation, the balance after paying for Primer to be put to my credit as a subscription toward The Age.

If there is anytihng on irrigation matters that you would like to know about India, I will be glad to send it to you. Have you got the Irrigation Commissioner's report, four big volumes of invaluable information? If the editor would like a copy, I shall be glad to try and get one for him. It might be worth while to send out sample copies of your paper to some Indians interested in irrigation. I am very pleased to see the circulation of The Age extend to India, as I have got lots of good ideas from it and I am sure others could also. The sending of the subscription is the difficulty.

Wishing you success, I am, Yours sincerely,
T. R. J. Ward.

Socorro, N. M., July 10, 1904.

The Irrigation Age, Chicago, Ill.

Gentlemen: You may resume my subscription to The Irrigation Age until further notice. Irrigation has been practiced in this valley for ages, in fact, the only sure and safe way to raise any kind of a crop almost anywhere in New Mexico is through a wise application of water, the rains here being an uncertain and out of season quantity. In my native country I have learned the utility of water for irrigation; both in France and Italy it has been a necessity. In this valley but a very small percentage of farmers use fertilizers, mostly barnyard stuff. The soil is rich and when water is plentiful, there is an abundance of crops.

This year, however, the source of water for irrigation has failed us; the Rio Grande, which supplies water for all community ditches, some of them ten or more miles in length, has gone back on the farmers early in the season. Some of the farmers got only one irrigation, others none. The effect is that the wheat crop has been a total failure and there is a loss of thousands of dollars in alfalfa and other crops. The Rio Grande River has been in the habit of going back on the New Mexico farmers for some eight or ten years. It has never happened before, though, to be as dry as early as in the month of April.

There is no other recourse left the Rio Grande agriculturist to make sure of his crops than to go to the expense of putting in irrigating plants and to pump water from the underflow, which is abundant anywhere in the valley at the depth of from ten feet down. This is their only salvation; it has come to this: either irrigation or emigrate to better favored regions.

Yours truly,
P. A. Marcellino.

St. Cloud, Minn., August 31, 1904.

Irrigation Age,
112 Dearborn Street, Chicago, Ill.:

Dear Sir—On September 28, at Litchfield, Minn., bids will be received for the construction of about fifty miles of open ditch. These ditches are too large to be dug without the use of a dredging machine, and unless the owner of a machine shall bid on them it is not probable that any bids will be received. Later in the fall other ditching jobs will be sold to the amount of about 800,000 cubic yards in all. Anyone having a machine to use on these ditches could probably secure these contracts at from 13 cents to 20 cents per cubic yard. The ditches have a slope of one to one and a depth varying from one to twenty-one feet. The contracts must be completed by January, 1906.

John N. Gaynor, of Litchfield, lets the jobs, and Arthur E. Morgan, of St. Cloud, is the engineer. So many ditches have been planned in central Minnesota to be constructed during the season of 1905 that it is going to be very hard to find contractors to handle all the work. Perhaps 10,000,000 cubic yards of excavation have been planned for the coming season within 100 miles of Minneapolis.

Very truly yours,
Arthur E. Morgan,
Per J. E. M.

DRAINAGE OF FARM LANDS.

Results of Careful and Extended Investigations by the Government for the Benefit of the Farmers.

BY C. G. ELLIOTT,

Expert in Drainage and Irrigation, U. S. Department of Agriculture.

From Farmers' Bulletin No. 187, Courtesy U. S. Department of Agriculture.

(Concluded.)

The irrigator applies water by surface flooding, using such quantities as his judgment and experience may dictate, feeling sure that any excess which he may apply will speedily pass down into the earth, which, under primitive conditions, being dry to a depth of from forty to sixty feet, porous and open, affords unlimited drainage facilities. The large amount of leakage from main canals and the surplus from over-irrigation for a time find a ready and harmless exit into the lower soil. Under such conditions the understrata become a waste reservoir which receives by percolation the leakage from irrigation canals and the drainage from over-irrigation, thus securing to the cultivator as perfect soil conditions as could be desired.

Many of these soils contain considerable quantities of soluble (alkali) salts, prominent among which are sodium chloride, sodium sulphate and sodium carbonate, which originate in the rocks from which the soils are formed. Lands which up to a certain time have produced crops in quantity and quality to which no exception can be taken may, without apparent cause, begin to deteriorate. Upon examination it will be found that the alkali salts have accumulated near the surface in such strength as to destroy crops that had previously been grown successfully. Upon further investigation as to the cause, it is found that the water in the lower soil has dissolved large quantities of alkali and holds it in solution. The rise of water to a plane at or near the surface from which rapid evaporation takes place results in the deposit in solid form of all the alkali contained in the water evaporated. The active capillary power of the more finely divided soils accelerates the upward movement of the water, the evaporation of which is rapid in arid climates, resulting in a deposit which constantly increases from year to year.

The presence of layers of hardpan at irregular intervals throughout the upper six feet of the soil, as well as occasional layers of gravel deposit and adobe clays, has had much to do with the deflection and concentration of soil water. By reason of hardpan layers the excess of water is brought to the surface more directly at some points than at others. Under the action of soil water some varieties of hardpan soften and gradually disintegrate, thus changing the general texture of the soil where it exists. The need of drainage of such soils as a preventive of the injuries noted, as well as for the restoration of land to its normal productive condition, is appreciated. It is not proposed here to discuss at length the varying conditions existing in different localities, but to call attention to the success that has attended the efforts of some farmers who have reclaimed land from the effects of seepage and alkali.

In the treatment of lands of this character it must be remembered that the conditions under which land becomes saturated by seepage are radically different from those of rainfall. In irrigated lands the water accumulates at various points by underflow from the waste of irrigation practiced upon more elevated land adjoining, or from leakage of supply ditches which are constructed through previous material. The prevention of the accumulation of water in harmful quantities is best accomplished, not by its removal from the soil after saturation of the land, but by intercepting it before it reaches the lower level. A few examples of this kind will indicate that the method most successful differs quite materially from that used in humid areas.

Albert Igo, near Greeley, Colo., has used a series of small wells located at points where water appeared, sinking them into the gravel which lies beneath the saturated soil. The wells consist of curb boxes twelve inches in diameter, made with eight sides, from boards one inch thick. They are sunk from eight to twelve feet deep, the excavations being made with a large auger. The wells have underdrain outlets about three feet deep leading to a surface ditch. The water rises at once in these wells to the height of the outlet provided and flows away. The soil, which is about five feet deep, is underlaid with gravel, which, through the process of seepage from higher lands, has become surcharged with water which, by reason of constant pressure and continual supply from land occupying a higher level, saturates the soil above the gravel. These wells, put in at various points where water appeared, reclaimed at small cost a field which had been given over to grazing land on account of the saturation and alkali.

This method of draining is regarded as highly successful by the farmers of the vicinity who have witnessed the reclamation of the land so treated. The individual well and drain as used in the work described are shown in Fig. 18. The method is simple. Its efficiency consists in relieving the pressure of the underground water at such a depth that it will not continue to force itself upward against the soil, and also in removing such a quantity that the gravel stratum underlying the tract will provide for the remainder.

Drains upon another plan have been used by J. Hetzel and others in the vicinity of Longmont, Colo. A continuous line of underdrains is laid crosswise of the slope along the upper border of the lands showing seepage. These drains are laid five feet deep, which is regarded as necessary to their success. The subsoil is adobe clay, in which pockets of sand are encountered which interefere with the laying of the drains. The method of location is shown in Fig. 19. The drains are made of one-inch boards in the form of a continuous box, 6x6 inches in the inside, with no bottom. These drains, complete, cost $1 per rod. It is not uncommon in this vicinity to find one drain located in this manner intercepting sufficient water to reclaim forty to eighty acres of land, where the soil is of a stiff nature. Where soils are open and admit of very free percolation of water the same plan is applicable, but the size of drains must be increased. The quantity of water which it is necessary to intercept is greater than is usually suspected, and some failures to obtain good results are probably owing to the fact that the drains are too small. Shallow drains do not accomplish the desired result, nor do drains laid up and down the slope accomplish the work as fully and cheaply as those laid across the slope.

Where drains are laid in wet land its unstable condition and water-bearing sand pockets often make it impracticable to use short tiles unless laid upon a broad base. Sewer pipes known as "seconds" may sometimes be used in place of drain tiles with better success because of their greater length and the addition of sockets which aid in holding them in alignment.

The plans of treating land for the purpose of redeeming it from alkali which has accumulated through evaporation and seepage are not uniform, nor is there any practice which has been so reduced to a system as to justify an authoritative statement of methods that may be best employed. The cutting off of the underground supply by drainage has often resulted in the full reclamation of the land, with no other treatment than subsequent irrigation and cropping. In other instances more complete underdrainage and special irrigation with cultivation for two or more years has been found necessary.

The experience of R. P. Tjossem, of Ellensburg, Wash., in reclaiming alkali land proves that it can be done by underdrainage and subsequent irrigation. He has tried mole drains and box drains 2x2½ feet deep, also box drains four and a half feet deep. His draining was not done systematically, but experimentally, and was continued over a field of seventy-two acres in a random way. He discarded the shallow system of draining early in the work and adopted four and a half feet as the minimum depth at which drains should be placed. He is now of the opinion that five feet is preferable. He irrigated liberally, and by subsoiling turned the surface soil down as deeply as possible and irrigated again. The land was seeded as rapidly as possible, the completeness of the reclamation being indicated by the growth of the crops planted. Some parts of the field were soon producing a paying crop, while others were more stubborn and required further irrigation and cultivation. At the end of five years the entire tract produced a profitable crop of alfalfa and timothy. In the sixth year only small spots remained which failed to produce a good average crop of grass. This field at the beginning was badly affected with alkali, and is described as absolutely barren, black alkali being prominent among the salts. The drainage was meager and experimental. The field is now pointed to by neighboring farmers as an example of the successful reclamation of alkali land by underdrainage. The cheapest and most effective methods and the details which practical farmers desire to know are not as fully demonstrated as they will undoubtedly be later on.

Attention was called to this land and the method of its reclamation in Bulletin 49 of the Washington State Experiment Station, issued in 1901, in which is described quite fully the nature of the soil and the percentage of alkali it then contained. The fact that, in 1903, $1,500 worth of hay was harvested and sold from this field, while the land adjoining it remains highly charged with alkali and produces only salt grass, proves in a most positive way the value of drainage as a factor in reclaiming alkali land. A calcareous hardpan is found over a considerable portion of land in that locality. When it is encountered it costs 75 or 80 cents a rod to dig a ditch five feet deep by hand labor. Where this does not exist 50 cents a rod is a fair estimate of cost.

THE GOVERNMENT FORESTRY EXHIBIT.

WHAT IT COMPRISES AND HOW IT IS ARRANGED AT THE ST. LOUIS FAIR.

Both Indoor and Outdoor Features Described. Large Collection of Transparencies Illustrating Forests and Forest Work in the United States. Timber Tests, Wood Preservation and Methods of Turpentine Orcharding Special Features.

The Bureau of Forestry of the United States Department of Agriculture has prepared for the Louisiana Purchase Exposition the most extensive display it has ever made. The purpose is both to illustrate the work which the Bureau is doing and to show actual forest conditions in all parts of the country. The visitor will see there the most impressive evidence of what practical forestry is, and also its great present and future importance as a means of promoting the national welfare. Lumbering ranks fourth among the industries of the country, and it is a matter of hopeful promise for the permanence of the industry and for the cause of forestry that lumbermen are adopting conservative forest management in their lumber operations. That agriculture, incomparably the most important of our national sources of wealth, also depends in no small degree on forestry, is not, however, so well understood. Under intensive methods of farming, and with the enlargement of the cultivable area made possible by irrigation, this dependence will become increasingly close. Mining and grazing, too, materially depend on forestry, for mines demand cheap and abundant timber, and the forage which feeds most of the western stock is one of the important indirect products which, under proper restrictions, the forest may be made to yield. All of these relationships are strikingly displayed in the Forestry exhibit at St. Louis.

The space allotted to the Bureau of Forestry is in two different though not widely separated parts of the Fair grounds. An indoor exhibit is located in the Forestry, Fish and Game Building, in which is centered also an exhibition of the lumber industry of the United States. A striking and complete collection of photographic transparencies illustrate forest conditions and problems as they are encountered by the Bureau. Typical single trees and forests, the cutting or harvesting of forests and their renewal by natural reproduction, forest planting in treeless regions or where forests have been destroyed, and damage by fire, insects, over-grazing, etc., are shown most clearly. Nearly all of the transparencies are of large size, some of them four by five feet. They are arranged to be seen from the inside of an arcade illuminated by natural light, with eastern and western forest scenes shown on opposite walls. This series is supplemented by a collection of large colored bromide photographs framed in the panels of the balustrade which surrounds the exhibit space. On the floor between the balustrade and the arcade are cases which display some specially important phases of the Bureau's investigations, together with a collection of all the instruments used in forest work, the publications of the Bureau, etc. Of particular interest is a large case containing longleaf pine trunks which show the advantages of the new system of turpentining promoted by the Bureau and the disadvantages and injurious effects of the old system of boxing. Two other cases exhibit

insects and examples of their destructive work. The method of determining the strength of commercial timbers is shown by a testing machine, while the results of tests are shown by charts and tested timbers. There is also a large collection of timbers, both from the United States and Europe, treated by different preservative processes to show the manner of increasing the life of various construction timbers. Several specimens are shown of building and other timbers which have been in use for thirty years or more.

One of the special features of the exhibit is a relief map of the United States cast upon a section of a sphere sixteen feet in diameter. By using this type of map the geographical distortion inevitable in flat maps is avoided, and the real relationship of the various parts of the country and their actual position on the globe are correctly shown. The distribution and character of the forests of the country are shown in different colors, as are the location and extent of National and State forest reserves. The forests managed according to working plans prepared by the Bureau and lands upon which plantations have been instituted under Bureau planting plans are also indicated by special symbols. The situation of forest schools and other institutions which afford training in forestry is shown on the map. On another relief map are shown the location of the proposed Appalachian Forest Reserve, the extent and character of forest and other lands included, and the relation of the reserve to the surrounding country.

THE FUTURE OF SALT LAKE.

No other city of the West can, with resonable assurance, look forward to the developments of the next five years with as great confidence as does Salt Lake.

The center of a region of mineral wealth, the mines of which have already paid more than $70,000,000 in dividends, and which even yet is comparatively undeveloped, Salt Lake is fast becoming one of the greatest of smelting centers and is now taxed to find facilities for handling the constantly increasing mineral production.

The vast irrigation enterprises now under way by the United States Government will reclaim a great empire of Utah's arid land, adding to the already rich agricultural and horticultural resources of the State and will afford opportunities for tens of thousands to secure good homes in the region tributary to Salt Lake.

The certainty of three new railroads will make Salt Lake the railroad center of the West and draw to it the wealth and trade from a vast extent of naturally rich and hitherto undeveloped country. The roads centering in the city are spending millions in the improvement of terminal facilities and depots, and at the same time constantly bettering their trackage and equipment.

Salt Lake has gained steadily in population during the past five years, has now upwards of 80,000 inhabitants, and according to the constantly increasing ratio of growth will pass the 100,000 mark before the present decade passes.

Salt Lake is primarily a city of homes. The hundreds of new houses that have been erected annually during the last three years have in the great majority of cases been for owner, not tenant, and it is certain that this year's building record will pass the $2,000,000 mark set by 1903.

For attractiveness, both in winter and summer, the city is admittedly unsurpassed in climate; its school system is the best and most modern in the West, its home resources are more varied and extensive and it offers the best opportunity for the wage earner who seeks a home, for the business man who wants a location, for the capitalist who is looking for profitable investment.

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THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

OCTOBER, 1904.

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ONE DOLLAR A YEAR

SPECIAL FEATURE

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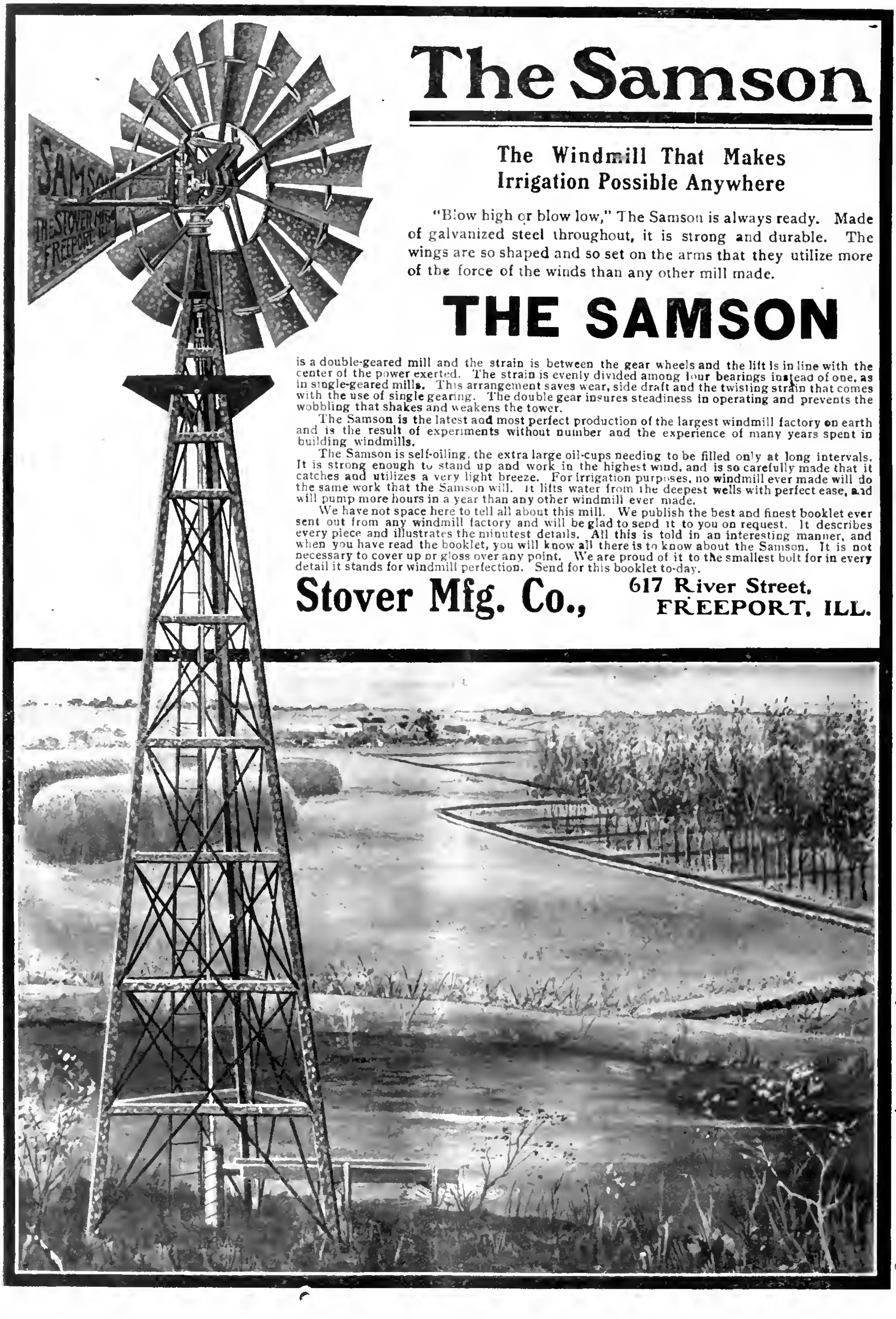
WITH WHICH IS MERGED
THE DRAINAGE JOURNAL
ESTABLISHED 1879

CHARLES A. COX CHGO.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"Blow high or blow low," The Samson is always ready. Made of galvanized steel throughout, it is strong and durable. The wings are so shaped and so set on the arms that they utilize more of the force of the winds than any other mill made.
THE SAMSON
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We have not space here to tell all about this mill. We publish the best and finest booklet ever sent out from any windmill factory and will be glad to send it to you on request. It describes every piece and illustrates the minutest details. All this is told in an interesting manner, and when you have read the booklet, you will know all there is to know about the Samson. It is not necessary to cover up or gloss over any point. We are proud of it to the smallest bolt for in every detail it stands for windmill perfection. Send for this booklet to-day.
Stover Mfg. Co.,
617 River Street,
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THE IRRIGATION AGE

VOL. XIX CHICAGO, OCTOBER, 1904. NO. 12

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION THE DRAINAGE JOURNAL
THE IRRIGATION ERA MID-WEST
ARID AMERICA THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

AN IMMEDIATE NECESSITY

A general demand will be made soon by leading citizens throughout the west, asking for the appointment of a commission to supervise the expenditure of the large fund accumulating under The Reclamation Act. Judging from the reports which reach us of lavish expenditure, a commission is an immediate necessity.

Irrigation Pays Everywhere. Too many farmers in the East and Middle West look upon irrigation as a subject that is far removed from themselves. They recognize that the principle of irrigation is right, but believe that it is only to be applied in the arid regions of the far West. This is a common mistake and one that is costing old established farmers a great deal of money.

Irrigation pays everywhere. No other principle is so applicable or so important where a land owner is trying to diversify his products. The greater the diversification the greater the need of irrigation. If the watering of the soil by artificial means pays where a single crop is raised, it pays four times over where various crops are raised, for some farm products and some fields require much more water than others, and it is only by practical irrigation that the tiller of the soil is able to regulate the supply of moisture and give to each article or each field what is required.

The old farms of the East and Middle West can be made to produce amazing results by irrigation. Another fact is that the long established farmer is usually able to pay for needed improvements. Farmers in the older sections of the country must get over the idea that this great scientific principle is entirely for people elsewhere. It is for the farms of Illinois, Indiana, Wisconsin, and even for those of New England and the old South.

Retain Good Men In Office. The death of Senator Hoar, of Massachusetts, brings to mind a point in which the East sets a wholesome example to the West. The old Bay State has usually honored herself in honoring her most distinguished sons. She seemed to take pride in Senator Hoar's conspicuous ability and exalted character and overlooked the fact that he was frequently at variance with the Republican administration. The venerable statesman was seldom in accord with the so-called party leaders, but this did not weaken him with his constituents. He was useful to Massachusetts and reflected credit on the people who retained him in the public service during the best years of his life. He was in office upward of fifty years.

Examples of this kind are numerous in the East. Occasionally an unworthy man is retained in office, but this does not disprove the fact that the East is more

keenly awake than the West to the importance of retaining good men in office. The lesson is more particularly for the new States, some of which have at times lost prestige and influence at Washington by retiring men of high character from Congress.

It is the new and undeveloped section of the country that has special need of trained and influential men at Washington. The new member, as a rule, accomplishes much less for his State than the old one. Government officials will do more for a state which keeps its good men at the front than for one which makes frequent changes at the dictates of bosses and rings.

A Land Of Opportunity. One of the newest sections of the northern frontier is being opened to settlement largely through the influence of Chicago men and Chicago railways. This is a large belt of land lying south of the Northern Pacific line and west of the Missouri River in North Dakota. In fact it extends from the river west to the Missouri line and beyond. Much of the territory known as the bad lands is embraced. It is a region adapted to general farming, but particulary live stock raising. President Roosevelt and the Marquis de Mores had their ranches on the Little Missouri River, in the locality under consideration, twenty years ago. Along the streams the country is fertile and the grazing excellent, but on the uplands there is always more or less danger of drought. With irrigation the entire region, which is larger than some of the European kingdoms, could be made highly prosperous. It is already a picturesque and healthful place. The career of Roosevelt and De Mores cast a romantic glamor over that locality which clings to it to this day.

Just before their advent in the northwest that region was made famous by Gen. Custer's last campaign and the massacre of his command. Custer's tragic death occurred on the Little Big Horn River. The Black Hills are to the southeast and the Yellowstone Nathional park to the west. The Northern Pacific railway strikes the Yellowstone River at Glendive, Mont. The town of Medora, which the Marquis de Mores named in honor of his young wife, a New York belle, is situated in North Dakota just across the line from Glendive. Miles City is the first prominent station west of Glendive.

There has been much talk about the opening of of the two Indian reservations in that section of country during the past few months, and it is worthy of note that the unoccupied lands between the Missouri River and the head waters of the Yellowstone are ten times more extensive than these reservations and equally attractive and valuable in every way. Several railway lines are needed to bring the locality to its best.

East of the Missouri the country is well supplied with railroads, but to the west there is urgent need of north and south lines to intersect the Northern Pacific and the Great Northern. A much more rapid settlement of the territory would take place were there ample shipping facilities. Several of the big companies appear to be getting ready to meet this want and a good many Chicago capitalists have interests there.

One of the great advantages is the abundance of coal. Settlers are perfectly independent on the fuel question. The entire west Missouri country in North Dakota is underlaid with a good quality of lignite. Farmers as a general thing find what they require on their own homesteads and it is often the case that they are able to market enough of the product in the towns to pay for their general household supplies. In this respect they are better off than most of the inhabitants east of the Missouri River, where the population is becoming quite dense. Where people have capital enough to mine coal extensively it is a profitable business. This kind of enterprise will develop as new railroads are constructed.

The fuel question being settled, the inhabitants are in duty bound to take up the subject of irrigation. Mixed farming reaches its highest state of prosperity in the Dakotas when there is an abundance of water, and on the new frontier this will have to be attained by artificial means. By clubbing together, the settlers in any locality can irrigate their land with artesian wells. The laws are liberal and considerable aid is given where citizens are disposed to co-operate with the state.

While North Dakota leads the world for the excellence of its wheat, it is also unsurpassed for raising live stock. The State has superior educational facilities and is occupied by a progressive class of people. Investors in land in that State have made a great deal of money during the past two years. This is particularly true of the James River Valley and the Missouri Valley, where land is cheap.

Not only are deeded farms cheap there, but Government land may still be obtained under the homestead and pre-emption laws.

WALTER S. CHURCH, C. E.

Distinguished Member of Civil Engineering Profession Passed Away.

Walter Stewart Church, the well known civil and mining engineer, died at the home of his brother, John B. Church, 844 South Main street, Geneva, N. Y., August 30th.

The direct ancestors of Mr. Church embraces some of the most distinguished names in the history of the country, such as Gen. Philip Schuyler, Jonathan Trumbull, the Van Renselaers, Van Cortlandts and Livingstons.

He was born in Angelica, Alleghany County, N. Y., August 29, 1832. He was educated at General Russells and Hopkins Grammar School, New Haven,

and entered Yale College in the class of '54. His health failing, he left college during the freshman year to travel in Europe with his grandfather, Prof. Silliman Sen. Upon returning home he entered Dartmouth College, graduating with the class of '56.

Choosing engineering as his profession, he began work on railroad surveys in Illinois under Major Sidell and later was with Gen. George Green on the hydrographic surveys of the Croton watershed and in laying water mains in New York City. In 1861 he was appointed by the Peruvian Government engineer of state, with headquarters at Lima, Peru, and for upward of four years was engaged in making surveys for water works, harbors and railroads, making the first map of the old Inca capital of Cuzco, including the famous fortress of Sacshuman, whose fall completed Pizarro's conquest of Peru. Returning to the States in 1866, he had charge of the gold mines in Eldorado County, California, and projected and surveyed the water works for the University of California. In 1873 he joined his brother, John Church, manager of Alliance Coal Mining Company, at Pottsville, Pa., acting as mining engineer for that company for ten years, retiring from the mines to take charge of the record department of the new Croton aqueduct commission, of which his brother, Col. Benjamin S. Church, was the chief engineer. Since the completion of the new aqueduct he had been employed chiefly in making reports on gold and silver mines in the West, and lately, until disabled by illness, with the United States engineers on the improvement of the navigation of the Hudson River.

He was a member of the Society of the Cincinnati, of the American Institute of Mining Engineers and the Engineers' Club of Philadelphia. Mr. Church was a man of exceptionally attractive personality. A gentleman of the old school, unswerving in his integrity and ever ready to lend a helping hand or do an act of kindness. He was unmarried. He is survived by one brother, John B. Church, and one sister, Mrs. Coffin, of Boston.

The North Dakota Republican State convention paid its respects to the action taken by the Democratic convention at St. Louis in the following resolution:

"We commend the Democracy for its generous expressions of approval of the patriotic work of Lincoln, Grant, McKinley and other great Republican leaders who are dead, but we seriously object to the policy inaugurated at St. Louis whereby the Democratic national convention sought to deprive the administration of Pesident Roosevelt of any credit for its work in the passage of the Hansbrough irrigation law. This legislation was enacted in 1892, under a Republican President and by a Republican Senate and House of Representatives, the bill having been drawn, introduced and managed by Mr. Hansbrough in the Senate, and when it reached the House of Representatives Mr. Mondell (Rep.), of Wyoming, took charge of it and secured its passage by that body. It was then signed by President Roosevelt and became a law.

"There is no statute law applicable to such a theft as was perpetrated by the Democracy at St. Louis, but the moral obligation to protect the Republican national administration from the political cracksmen rests upon every Republican in the land and particularly upon this convention."

THE DEFECTS IN OUR CANALS.

The purpose of a canal is to convey water from one place to another, but if one-third seeps through the bottom and sides along the route the usefulness of such a canal may be called in question. It is not enough that we merely provide a channel, but we should also ascertain if it will hold water. If not, the proper time to remedy so serious a defect is when the canal is being built. It costs but a trifle more to excavate the bed a few inches below grade and fill the space thus made with good puddle. If this were done at the worst places along the route the value of the water thus saved in one season would frequently pay for the extra cost involved. Here in the Rocky Mountain States water is usually abundant, especially in seasons like the present. Instead of using impervious channels, such as lined canals and closed pipes, water is conveyed in open ditches over porous formations of loose earth and gravel.

Flooding is usually practiced, not because it is the most economic of water, but because it is the cheapest. In view of the fact that large volumes of water are daily diverted and applied to dry soil during the summer season in such manner as to admit of a large percentage of waste, it is not surprising that this waste or seepage water becomes an important factor in the irrigation of a district. Whenever water is conveyed in channels excavated in ordinary soils and subsoils, a large percentage of the flow is absorbed by the porous materials forming the bottom and sides of the channel. In the past writers on irrigation have frequently attributed this loss to both evaporation and seepage.

This may account for the false impression that prevails among irrigators as to the real cause of the loss. Many claim that it is chiefly due to excessive evaporation. One man whom we know, after thirteen years of continuous service in operating a canal has reached the conclusion that the loss in conveyance, which forms about one-third of the total flow, is due almost wholly to evaporation. As a matter of fact, the loss due to evaporation is so small when compared with that from seepage as to be scarcely worth mentioning. On this particular canal the quantity of water evaporated during a hot day in midsummer is equivalent to the continuous flow of one cubic foot a second for the same period, while the quantity lost by seepage amounts to seventy-five cubic feet a second. In other words, the loss due to seepage is seventy-five times greater than that due to evaporation.

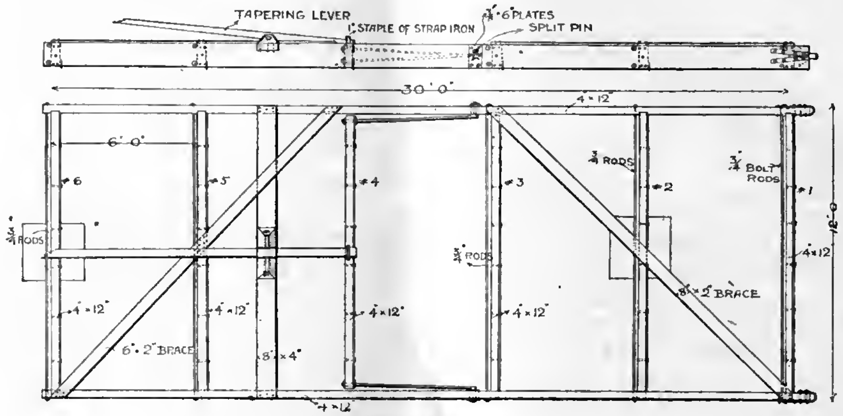
It is true that a large part of the water used in irrigating is evaporated, but this takes place after the water has been spread out on the fields and not to any great extent while confined in the canal. This fact should be clearly understood by irrigators or otherwise the defects in existing canals will not soon be remedied. So long as the owners believe that the loss of water is principally due to evaporation, over which they have practically no control, they will be content to let things alone. Whereas, if the truth is made clear that evaporation from the surface of canals is insignificant and that from fifty to a hundred times more water escapes through the lining of the bottom and sides, they will realize this great loss may be in a measure prevented and the stream which now waters only seventy-five acres may, if conveyed in a more impervious channel, supply water for 100 acres.—*Denver Field and Farm.*

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, Courtesy U. S. Department of Agriculture.

INTRODUCTION.

The diversity in irrigation methods in use on western farms is largely due to the early training and environment of the irrigators themselves. Among the 120,000 irrigators of Western America are to be found nearly all classes and nationalities. Each settler from another State or from a foreign country introduces on his farm some custom or practice common to his old environment. This is particularly noticeable in the conservative Chinese, who irrigate the truck gardens near towns and cities in Chinese fashion. The same is true of the Italians, Spaniards and Mexicans, who imitate for a time at least the ways of their forefathers. It also applies, but to a less degree, to those who come from humid States. The farmer who lives until maturity in the Mississippi Valley and then moves west onto an irrigated farm does not as a general thing adopt new ways of farming until crop failures compel him to do so. Even then the old ways of doing things are mixed with the new.

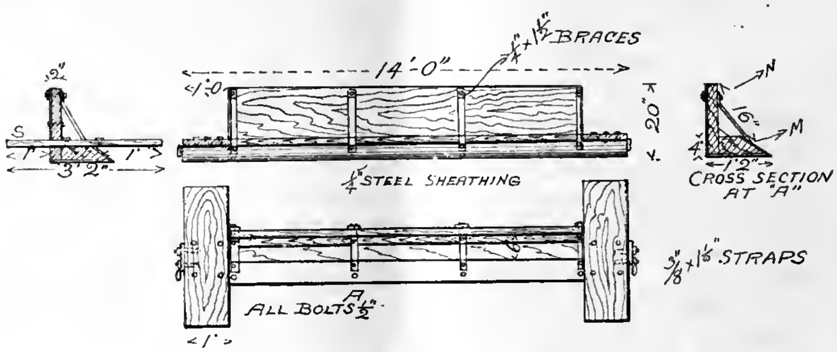


Rectangular leveler.

Then, apart from the influence which early training may exert, there is always present the vital question of money. Many new settlers have not the means to prepare their fields for easy and efficient irrigation. They are compelled to resort to crude methods, which rob them of a part of their possible profits.

The large stockmen pasture cattle and sheep on public lands and irrigate only sufficient native meadow and alfalfa to supply the needs of their stock in midwinter. With this class irrigation is a side issue and seldom receives the attention which it deserves.

Others again have another excuse for their poor methods. They are tenants and wish to obtain the greatest immediate returns for the least possible expense. At the other extreme one finds the so-called "agriculturist," who makes his money selling merchandise in the city and spends it on his farm in the country. This class is content with small returns for large outlays; for to such people farming is a pastime.



Modified buck scraper (planer).

The size of the farm has also much to do with the manner of irrigating it. On large farms it has been difficult of late years to hire the help needed during the busy season. In consequence, owners have been forced to expend more labor and money in preparing the surface for more rapid and easy irrigation. On the other hand, the farmer who cultivates a small tract with the assistance of his boys can obtain better crops at less cost for implements, machinery, and materials by going without the latest improvements and having all labor performed by the members of the family.

Another cause of diversity is the character of the water supply for the farm. The way a field is watered frequently depends on the manner in which water is delivered. One man may receive a small flow continuously for months, another may receive a large volume for a short time, and a third may be dependent on a mountain creek which may have a flood in May and be dry in July. It will be readily seen that all irrigation works pertaining to the farm should be

planned to suit the source from which water is obtained and the regulations governing its delivery.

Climate has a still greater influence. It is the cloudless sky, the high summer temperature, the excessive evaporation, and the lack of rainfall that compel Western farmers to irrigate. It is none the less true that the elements which go to make up the general term "climate" differ in every locality. Over the vast area of 1,433,830 square miles which lie west of the one hundredth meridian there is the widest diversity. No two States or river basins have the same climate. On the border land between the wet and dry regions irrigation is not an absolute necessity. It is resorted to only in years of scanty rainfall. At the other extreme is the irrigated section of southern California, where irrigation not only is a necessity, but must be practiced the greater part of the year. The average annual rainfall at San Diego, Cal., for example, for the past fifty-two years has been only 9.43 inches. What is true of rainfall applies with equal force to evaporation and temperature. The evaporation from an irrigated field in Arizona in midsummer is quite different from what it is in Wyoming.

There is a wide diversity in the soils and subsoils of the arid region. This diversity calls for modifications in the methods employed in preparing the surface and applying the water. The farmer in one locality can not use the furrow system on account of the porous nature of the soil and subsoil. A stream might run for days and days in a furrow and not advance beyond a sandy "sump." In other localities nothing but furrows can be used for the reason that the fine particles of basaltic soil bake so readily when the surface is flooded as to damage the crops.

The nature of the surface, as well as the steepness of the slope, is likewise to be considered. The hog wallows of California are first cousins to the buffalo wallows of Montana. In every locality, wherever found, this unfavorable formation of alternate height and hollow must receive special treatment. The methods suited to an even, uniform slope do not apply to such land.

A good example of steep grades may be seen in going from Sacramento, Cal., to Reno, Nev. The orchards on the western slope of the Sierras seem to be on edge. Here, as elsewhere throughout the West, costly trials and patient effort have finally overcome the difficulty, and these orchards are now irrigated with much the same ease as orchards on gentle slopes.

And, finally, the variety of crops raised is a cause of differences in irrigation methods. There is a wonderful diversity in the cultivated plants of the irrigated farm, from the native blue joint of the North to the date palm of the South, and from the corn fields of the East to the citrus groves of the West. For each of these scores of plants some particular kind of soil, climate, and locality will suit best. There is also for each the proper time to sow and to reap, to cultivate and to irrigate.

"Everything grows in California," said a Franciscan monk of Santa Barbara last April. This growth, however, is seldom due to natural conditions. The highest intelligence is required to sow the seed in the right place and to properly care for the plant. Frequently other soils and other climates produce the seeds which are made to flourish in a western desert.

Sagebrush Plain, Yakima Valley, Washington.

Many reasons might be given for publishing descriptions of different methods of preparing land and supplying water. It is thought advisable, for instance, that the farmers of one arid State shall be made familiar with the practices of those of their calling in other arid States. Again, since there are so many different ways of performing the same task, it is considered wise to bring together in one publication such information regarding different methods as will enable the reader to make an intelligent comparison. There is also a desire to place in the hands of the new settlers on irrigated farms some of the lessons of costly experience of the past fifty years.

In the reports given herein no effort has been made to cover the entire arid region or to describe all of the different methods adopted. Notwithstanding this necessary limitation, the information contained in this

bulletin represents in a general way the entire West.

The most prevalent mode of preparing the surfaces of fields, laying out and building lateral ditches, and wetting the soil in the following-named localities have been described:

State.	Locality.
Washington	Yakima Valley.
Utah	Cache la Poudre Valley.
Colorado	Salt Lake Basin.
Nebraska	Western Nebraska.
Nevada	Truckee Valley.
Kansas	Western Kansas.
Montana	Gallatin Valley.
California	Santa Clara Valley. San Joaquin Valley. Southern California. Imperial Valley.

Much more space has been given to California than to any other State. The reasons for this are not far to seek. In climate, topography and soil products it possesses a wide range. As a result there is not only great diversity in the kinds of crops produced, but also in the manner of preparing the land for irrigation and supplying it with moisture.

THE USE OF SCRAPERS.

Scrapers are in great favor for leveling land throughout California. In the Imperial Valley they are handled by Cocopah Indians, who work for $1.50 per day and board themselves.

The scraper most commonly used is strong, portable, and has a wide range of use. It loads quickly and loses but little in transportation. After the load is dumped the team may be turned readily, and when empty the scraper is drawn with sagging traces. It has, however, the following disadvantages: (1) The sudden strain on the team and the dumping bruises the shoulders of the animals; (2) skill in handling is necessary to rapid work and experienced help is usually difficult to find; (3) the laborers object to the constant lifting in loading and dumping; (4) large hummocks are often full of limbs and roots of mesquite; mesquite mines, so called, will catch on the blade of the scraper, making it impossible to load until the root is removed. Leveling with the scraper is more expensive than with the other implements yet to be described. However, hummocks ten to twenty feet in diameter and

Using Buck Scraper.

PREPARING LAND FOR IRRIGATION—CLEARING AND LEVELING LAND IN IMPERIAL VALLEY, CALIFORNIA.

The land in Imperial Valley has a uniform grade of from two to six feet per mile, which is well adapted to irrigation, but the removal of "mesquite mines," sagebrush, and greasewood on the top of hummocks taxes the ingenuity of irrigators. Sometimes the workmen remove the brush from the top of a hummock with mattocks. This method is slow and expensive, and the workman is often obliged to dig for a long time to remove a single gnarled root. A better and cheaper method is the use of a railroad rail to each end of which a team is hitched. The rail should be bent to a V-shape, thus giving much greater power in cutting and tearing up brush when dragged over and back. The brittle branches are broken off below the ground, or the shrubs are pulled up by the roots. The brush, which is quite inflammable on account of an oil which it contains, may be burned at once. The land is then ready for leveling. The implements most commonly used are the scraper, the rectangular leveler, and the planer.

five to ten feet high can be removed in no other way. But if such heaps of earth are numerous their removal will not be profitable for ordinary crops. Land of this character has been leveled with the scraper at an average cost of $3 to $5 per acre. No attempt is made to have the land perfectly level; the farmers are satisfied with a uniform slope.

THE RECTANGULAR LEVELER.

Land on which the hummocks are more or less uniform in size can be more cheaply and quickly leveled by means other than the use of the scraper. An implement in favor in Imperial Valley for the reduction of these humocks is a rectangular leveler. This machine (Fig. 1) is large and strong enough to remove hummocks, shrubs, roots, and all. It is a rectangular frame thirty feet long and twelve feet wide made of four by twelve-inch timbers, preferably Oregon pine. The twelve-foot timbers, six in number and six feet apart, except No. 4, are spiked or bolted to the thirty-foot side timbers and have iron tightening rods beside them. Scraper No. 4 is attached to hangers in such a way as to be moved up and down by a

lever. Each crosspiece is shod on the wearing side with plates of steel three-eighths inch by six inches; thus each acts as a scraper. The machine weighs 1,600 to 2,000 pounds. It is drawn by sixteen horses attached by chains and eveners to the ends of the side timbers. Cross braces of two by six-inch timbers give rigidity against strains in drawing and turning. The leveler is shown in the upper part of Figure 1.

The machine is practically six levelers, each made more effective by the total weight including the operators. The large chains and eveners by which the team is attached are of no small value in preparing the way. If the hummock is capped with brush the tops are broken by the eveners, the stems are scattered, and the earth is loosened. The first leveler carries before it and gradually crushes most of the brush and removes the top of the knoll, spreading the sand in a fan-shape in the nearest depression. The second leveler takes off more earth and carries it farther; the third continues the process. Scraper No. 4 is controlled by the lever and can be raised and lowered at will. This is of particular advantage if the knoll has become compact; for as much of the weight of the machine as desired can be applied to this scraper. The fifth and sixth levelers complete the process. The machine has the additional weight of the driver on the front and the lever tender on the rear. If there is uniformity in the size and position of the knolls, and this is where this leveler has its greatest value, the field is worked over in long narrow lands, from one-half a mile to a mile long and 100 or 200 yards wide.

MODIFIED BUCK SCRAPER.

This implement is especially useful on slightly uneven ground, small detached hummocks, or small washes. For this class of work it is preferable by far to any other known to the writer. A similar machine has been used in the San Joaquin Valley of California.

This leveler, called a planer (Fig. 2), is composed of a fourteen-foot horizontal or base timber four by twelve inches, and a back of two-inch lumber eighteen inches high. The timbers are held together by the extension of the steel plate with which the base is shod, and also by one-fourth and one and one-half inch iron straps from the top of the base to a point near the top of the vertical piece. The base is beveled toward the front and shod with plate steel to make it take dirt. Each end of the base extends one foot beyond the end of the vertical portion to which footboards are bolted. Outside of and below the footboards are the iron straps to which the teams are attached. On each footboard stands a driver of four mules, and together they govern the action of the planer. On approaching a small mound the drivers stand on the forward ends of the footboards, thus depressing the blade. As the planer moves forward a layer of earth is shaved off and gradually scattered as the weight of the driver is shifted to the rear of the footboards. The teams may be readily turned and the same mound again approached. The manipulation is very simple, easy and effective. The planer is of especial value in conjunction with the rectangular leveler described.

(To be continued.)

First Irrigation by furrow on New Plymouth Colony Co's land near Payette, Idaho.

F. E. & P. A. MYERS.

In this issue we are presenting the portraits of Messrs. F. E. & P. A. Myers, of the firm of F. E. Myers & Brother, Ashland, Ohio. Both of these gentlemen are thoroughly well-known throughout the United States in the implement and accessory lines, F. E. Myers being at the present time president of the National Association of Implement and Vehicle Manufacturers. This firm has developed within the past twenty-five years from one of small magnitude to one of the leading firms in the world. This splendid development has been due mainly to the remarkable energy and great business foresight of F. E. Myers, the head of the concern, who is generally recognized throughout the country as one of the leading men in the implement field. He has been ably seconded by Mr. P. A. Myers.

F. E. MYERS, Ashland, Ohio

P. A. MYERS, Ashland, Ohio

In a recent issue of an Ashland, Ohio, paper we find an extended notice of the fourth annual picnic given by the employes of F. E. Myers & Brother. This picnic is an annual event and this year proved a complete success, there having been nearly 3,000 in attendance. It was held on Silver Lake near Ashland. The consideration given F. E. Myers & Brother by their employes and friends is mutually complimentary, indicating clearly the good fellowship that prevails, and the proportions of their business accruing very largely from close application and judicious advertising.

SEABOARD AIR LINE MAGAZINE.

One of the handsomest and possibly the most costly pieces of literature ever issued by a railroad is the special southern edition of the Seaboard Air Line Magazine.

It is unique in that it contains absolutely no advertising, is practically free from reading matter, and embodies numerous full page and half page photogravures—the most exquisite examples of the modern printer's art, each one of them a gem and each worthy of framing. Across the book-sellers' counters this volume would easily command fifty cents per copy and will grace any drawing-room table. There is hardly a man or women in the United States who would not spend a fascinating hour or two in examining the beautiful illustrations.

There is an entirely distinct and separate pamphlet describing the Land of Manatee, and which is sent out accompanying the special southern edition of the magazine.

From the former one learns that the Land of Manatee is the most beautiful section of the world and but recently discovered by the Seaboard. The climate is delightful, the atmosphere salt-laden and perfumed by thousands of blossoming orange, lemon, grape-fruit and guava trees, and the most beautiful and fragrant of flowers. It is a land of ideal living, perfect health; a land of plenty, where crime, trouble and ill health are unknown. The entire set of booklets can be had by application to Mr. J. W. White, general industrial agent, Portsmouth, Va. Ten cents should be enclosed for postage.

NOTES ON IRRIGATION MATTERS IN AND AROUND EL PASO.

H. SCOUGAL, C. E.

It is not our intention to write up El Paso as a city, but to refer briefly to its surroundings and the wonderful productiveness of the soil of the Rio Grande Valley in its immediate vicinity. Without doubt, by the aid of water this section, of the Rio Grande Valley can be made the equal, if not the superior, of any alfalfa or fruit producing locality not only of Texas, but of the United States. At the present time in the immediate vicinity of El Paso matters appertaining to irrigation are in rather a revolutionary stage. This can be attributed in part to the cutting off of the flood waters of the Rio Grande by the irrigation in Colorado, which has gradually reduced the flow of this river in its course through New Mexico and Texas to practically "nil" except in the time of the big floods, which in these days of climatic changes have become very uncertain. It behooves the people of Texas, New Mexico and Old Mexico, who are interested in irrigable lands along the banks of the Rio Grande, to combine and put their right shoulders forward during the coming National Irrigation Congress and endeavor to get some permanent assistance from the Government, and we can not help thinking that they are entitled to substantial aid in one form or another, either in the form of a dam and reservoir at El Paso, or above that city and also a grant to test the underflow for an artesian flow of water which undoubtedly will be found not far from El Paso at a depth of from 2,500 to 3,000 feet.

The Government has a number of officials employed at this moment in and around El Paso and no doubt the district will derive some valuable information from them upon which to base the claims of El Paso for Government aid. During the past few seasons of scarcity of water, the residents of the valley have become awakened to the fact that what should be the annual rise of the Rio Grande can no longer be depended upon, and headed by the authorities in charge of the Agricultural College at Mesilla Park, windmills, gasoline and fuel engines have come largely into use owing to the fact that the underground flow, some forty-five to sixty feet below the surface, has been proved to be abundant, sufficient water having been found below the surface to irrigate every acre of the surface that is worth tilling. A farm of ten to twenty acres of land in the neighborhood of El Paso, when properly, that is, scientifically, tilled and irrigated, has been proved to net the owner as much as an average farm of 100 or 150 acres in the northern or eastern rain belt. Orchards, vineyards, strawberry patches and the minor berries in many cases are netting the growers over $100 per acre. As much as $800 was taken off an acre of strawberry ground in 1903 by Mr. J. J. Smith, an old resident and one of the leading men of El Paso. In short anything grows to perfection here under irrigation and the facilities and rates for shipping produce from El Paso are most favorable.

Harvest Scene, New Plymouth Colony Company's Land near Payette, Idaho.

So far the pumping systems are of the most diminutive type of gasoline engines and pumps, some running smoothly and well, others giving more or less trouble, but this latter class are few and are

the result of mismanagement or ignorance in erection and running. To remedy this under such favorable circumstances as exist along the banks of the Rio Grande, we would suggest that instead of each farmer purchasing a separate engine, let a co-operative company be formed to erect and install an electric power plant that would do all the pumping required for four or five miles above and below the power house, the farmer merely having to sink his wells, attach his pumps and touch the button when the power is required to start irrigating. All anxiety and annoyance of constantly sending to town for a machinist, gasoline and hire of an extra hand to attend an engine will be avoided and it will be found that irrigation will not cost one-half what it is now costing. Say a power plant was erected at Isleta and Mesilla Park from which all irrigation pumps within a radius of five or six miles can be run for five or six months in the year and if a contract were obtained to light one or two small towns at night and supply power for mills of one kind or another for six months of the year when irrigation is not on, it would be found that the cost of irrigation would be merely nominal.

In every way, unless an international dam be built near El Paso, El Paso must look for its water supply, both for irrigation and domestic purposes, to pumping; and we are convinced that the plant we advocate above, which has already proved successful in other parts of the world, would be of all importance to the irrigation of all localities situated under such circumstances as the farmers of the Rio Grande Valley for sixty to seventy miles above and below El Paso.

A dispatch from Trinidad, Colo., under date of September 1st, has the following:

Maps for the construction of an immense storage reservoir to be built about twenty miles east of this city on the Purgatoire River were filed in the office of the county clerk today by Charles R. Hays, of Denver. The maps have already been filed with State Engineer Carpenter in Denver and the project will cost $400,000.

A dam will be built at the upper end of Red Rock Canon 125 feet high and 337 feet long, and the reservoir will take in portions of four townships. The water will be used in irrigating a large area now arid between the dam and the town of Las Animas.

THE PRIMER OF IRRIGATION.

Chapter XVIII.

(Measurement of Water.)

If we fill a gallon measure with water we know that we have 231 cubic inches of water which weighs eight and one-third pounds. That is the United States standard. We also know, because it is easy to measure it, that a cubic foot of water weighs sixty-two and one-half pounds and measures 1,728 cubic inches, equal to seven and one-half gallons.

When it comes to measure water for irrigation purposes it is difficult to ascertain the exact quantity measured, owing to arbitrary standards of what the measure should be. Besides that, the various States and countries are not agreed upon a universal standard of measurement, so that when one reads of fifty inches being required to raise a crop, his measurement may mean a much less number of inches if measured according to some other standard. Ten thousand gallons of water by accurate measurement may be run into a reservoir, and in twenty-four hours or less that number of gallons will be materially reduced, but the loss can be accurately estimated, and so can the exact quantity run out of it for any purpose be measured almost to a drop. But in the case of taking water from a running or flowing stream or ditch, various difficulties stand in the way of accurate measurement.

In measuring water from streams, ditches and running or flowing water, generally three standards, or "units of measure" as they are called, have been agreed upon. They are the inch, the cubic foot per second, and the acre-foot.

THE INCH.

The "inch" as a unit of water measurement originated with the placer miners of the West and was adopted by irrigators when water came to be used upon the land for the growing of crops. It is the volume of water which will flow through an inch-square opening or orifice with a certain other volume of water over and above it to give it what is known as "pressure." Both the opening as to size and the depth of water above it are regulated by the laws of some of the States, and in

Road Bridge Across Main Canal—14 miles from dam. Twin Falls Land and Water Co.'s Project, Twin Falls, Idaho.

many localities it is regulated by custom—that is, by agreement. The definition given in the laws of Colorado will furnish an idea of what constitutes an inch:

"Water sold by the inch shall be measured as follows, to-wit: Every inch shall be considered equal to an inch-square orifice under a five-inch pressure, and a five-inch pressure shall be from the top of the orifice of the box put into the banks of the ditch to the surface of the water."

Of course, this opening may be larger than one inch square; for instance, six inches, or twelve inches, but in that case the inch will become multiplied into as many inches as there are inches in the opening. At six inches the volume of water would be thirty-six inches, and at twelve inches there would be delivered 144 inches of water. A simple and usual way to measure the inch and retain the pressure is to make the opening one inch wide and any number of inches long—a slot, so to speak; over this slot is arranged a sliding board that can be moved back and forth any number of inches of actual measurement with a carpenter's rule. By this device there will always be the required volume of water, or pressure, above the inch orifice.

Many irrigators roughly measure the quantity of water delivered from a ditch, or canal, by calculating the number of square inches in a cross section of the ditch and calling the result so many inches of water, but this is not a safe rule to follow, for pressure and the velocity of the stream of water are not taken into consideration, and they make a vast difference sometimes in the quantity of water delivered. The orifice measurement under pressure is the most accurate and gives better satisfaction.

The inch, however, as a standard of measurement, or unit, is of very little use except for the measurement of small quantities of water. It may be adapted to the distribution of water from small main ditches or their laterals.

CUBIC OR "SECOND-FOOT."

Owing to the inconveniences of the "inch" as a unit of measurement, and the limitation on the mechanical device for measuring it, the cubic foot or "second-foot" has been adopted as better adapted to the measurement of both large and small quantities of water; indeed, it is made the legal unit in most of the arid States and Territories in water contracts and for defining the amounts appropriated from streams. But although made the unit of measurement it is used in connection with the inch—that is, the cubic feet are distributed to farmers according to the number of inches it is supposed to contain. This is fixed by law and the following table will show the variations in the number of inches contained in a cubic foot:

Colorado—One cubic per second foot equals 38.4 statute inches.

Montana—One cubic per second foot equals 40 statute inches.

Idaho—One cubic per second foot equals 50 miner's inches.

Arizona—One cubic per second foot equals 40 miner's inches.

Nevada—One cubic per second foot equals 50 miner's inches.

Utah—One cubic per second foot equals 50 miner's inches.

A second-foot is a cubic foot which passes a given point in a ditch or canal in one second of time, and to measure the number of second feet it is only necessary to the number of seconds of time by the cubic feet of the stream to ascertain the total quantity of water. To make this clearer, let the reader imagine a small stream filling a square conduit or box one foot wide and one foot deep. This gives a stream the face or sectional area of which is one square foot. Now, if the water runs through this conduit or box at the speed of one foot per second of time, that will measure exactly one cubic foot per second, or one second-foot. If the water moves at a higher speed, as, for example five linear feet per second, the volume will be five cubic feet per second. If the conduit or stream is five feet wide and twenty feet deep, the area of its face is 100 square feet, and the water flowing one foot per second will give a volume of 100 cubic or second-feet; if it runs two feet per second, then the volume will be 200 cubic or second-feet per second of time.

In measuring the flow of a stream it will be understood from the foregoing that the width, depth and speed or velocity are calculated. Streams, however, are very irregular in their measurements and the velocity of the water is not fixed. For instance, the water flows more rapidly in the center or where it is deep; along the shore where it is shallow the friction against the bank and bottom retard it quite perceptibly. Moreover, the water flows more rapidly below the surface than at the surface. In such case it is estimated that the place of the greatest motion is about one-third of the distance beneath the surface, this being the locality where the water is least impeded by friction.

It is manifestly impossible for one to stand at the delivery point of the water, watch in hand, and calculate the number of second-feet that flow, hence a simple way of measuring the whole stream is quite common. A line, say 100 feet, is laid off along the bank and each end of the line is marked by a stake. Then a light float—a chip will answer the purpose—is cast into the stream above the upper stake and the exact time it passes is noted, and also the exact time it passes the lower stake. If the float requires twenty seconds to travel between the two stakes, then the velocity of the water is assumed to be five feet per second. Other floats are necessary, for the stream runs with unequal velocity, but the average speed together with the average measurement is taken as the basis of a calculation and the number of second-feet determined from that. Thus, if the width averages twenty feet, the depth four feet a cross section is eighty square feet. Then, if the rate of flow is two feet per second, we have a volume of 160 second-feet.

THE ACRE-FOOT.

The preceding water measurements are restricted to flowing water for irrigating purposes. There are numerous methods of measuring the volume of water more accurately than in the case of the chip, and it may be said that by means of submerged floats, current meters with electrical attachments, and other contrivances and calculations based upon scientific principles, very little water will escape the notice of the company who has it for sale, and the farmer may be sure of receiving all he is entitled to for his land. By and by it will be possible for the irrigation farmer to estimate exactly the quantity of water required by his plants, and that amount he will be able to give them with accuracy and without any waste or excess.

It is becoming the practice to store unused water

during the periods when there is an abundant supply—that is, to lay aside in reservoirs enough to meet any possible contingency of drought or insufficient supply when most needed. The standard of measurement of water stored in reservoirs, the unit of quantity, is designated as "an acre-foot"; that is, an amount of water which will cover one acre of ground, or 43,560 square feet to a depth of one foot. This will give, of course, 43,560 cubic feet, or 325,851 gallons. One cubic foot per second flowing constantly for twenty-four hours equals nearly two acre-feet, and from this it is not difficult to convert cubic feet into acre-feet and estimate the quantity of water to be stored in reservoirs for the use and requirements of crops. The reservoirs themselves may also be measured in the same manner as a tank, but allowance must be made for evaporation and absorption.

To further explain the technical units of measurements into quantities, the following table is given:

One second-foot equals 450 gallons per minute.

One cubic foot equals seventy-five gallons per minute.

One second-foot equals two acre-feet in twenty-four hours flowing constantly.

One hundred California inches equal four acre-feet in twenty-four hours.

One hundred Colorado inches equal five and one-sixth acre-feet in twenty-four hours.

One Colorado inch equals 17,000 gallons in twenty-four hours.

One second-foot equals fifty-nine and one-half acre-feet in thirty days.

Two acre-feet equal one second-foot per day, or .0333 second-feet in thirty days.

One million gallons equal 3.069 acre-feet.

Taking water from streams and ditches open to the atmosphere and its changes, rapid evaporation, seepage and absorption, is always attended with an enormous waste, the consequence being that the farmer never knows and no man can tell him whether he is giving his crops the quantity of water they absolutely require. He can not tell how much of the water applied to the soil is utilized by the crops, or is carried off by drainage, seepage, infiltration to some portion of the land where it is not needed and generally lost for useful purposes. He knows, however, that so much water is measured out to him and that he pays for the amount that runs through the head gate, whether it is of any practical use to him or not. The returns from his crops do not represent as much as he hoped, for the expense takes away a very large slice of his profits. His water tax may represent one-third of his receipts, and though he may be well aware that he never received the water he pays for—that is, it never was utilized by his crops—there is no way out of his embarrassment, he must pay or quit. His farm belongs to him—that is, he has the deed to it—but he is paying rent on it all the time.

But along comes the farmer who irrigates his land by means of a pump, worked by a windmill, horse-power, steam, gasoline, or electricity. This man says: "It costs me thirty cents per acre to irrigate my crops. I know just exactly how much water my plants need and I can measure it out to them as exactly as if I used a gallon measure." Then the big ditch man goes over to look at his neighbor's farm. "Why," he says, with a loud laugh, "you have only one hundred acres of land and I have five hundred." The other answers: "Very true, but I raise as much on my hundred acres as you do your five hundred, or nearly so, and with one-fifth the amount of labor and at a small fraction of the cost." "How do you make that out?" queries the other. "By making every drop of water do its work. I get out of it all the duty there is in it. I do not feed drainage, seepage, evaporation, and my water does not wander aimlessly all over the landscape. I am not in the business for the love of seeing water flowing over my land back into the ditches and wells of my neighbors, or into the subsoil to kill the roots; I am in it to make money, and I am making money by saving water, and I pay dividends into my own pocket, not into the pockets of some one else, who charges me for water I do not get. This is the era of small farms, and irrigation from wells." How the well man can make this pay will be described more in detail in the chapter on "Pumps."

ROOSEVELT ON IRRIGATION.

Writes a Letter to the State Congress in North Dakota.

MANDAN, N. D., Sept. 27.—Prominent citizens from all parts of the northwest are here attending the second state irrigation congress, which was called to order by President E. A. Williams in the Mandan opera house this afternoon.

After President Williams called the meeting to order Senator Hansbrough told of the benefits to be derived from irrigation.

At the close of Senator Hansbrough's address President Williams read a letter from President Roosevelt regretting his inability to be present. The letter is as follows:

"OYSTER BAY, N. Y., Sept. 19.—My Dear Mr. Williams: I am in receipt of your letter of the 15th inst., inviting me to be present at the North Dakota State Irrigation Congress on the 27th inst., and I wish it were possible for me to be present, but I regret to say it is not. During the time of my presidency there has been no measure in which I have taken a keener interest than that which started the policy of national aid to the cause of irrigation.

"I have felt that the use of the rivers and smaller streams of the States of the great plains and Rocky Mountains for irrigation was even more important to the future of this country than the improvement of the course of these same rivers, lower down, as an aid to navigation; and when I became president one of the first things to which I turned my attention was the effort to secure the passage of the law which inaugurated this system.

"I congratulate the people of North Dakota—indeed, I congratulate the people of all the United States upon the fact that this work has begun. It will be of incalculable benefit to the people of the semi arid regions and therefore to the people of the whole country, for in this country whatever benefits part of it benefits all.

"With best wishes, believe me, sincerely yours,

"THEODORE ROOSEVELT."

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

BROWNSVILLE, IND., Sept. 22, 1904.

THE IRRIGATION AGE, Chicago, Ill.:

Dear Sirs—I am just now on a visit here at my old home in the "States," and as we are particularly interested in irrigation and ditching machinery, I should be pleased to get in touch with your advertisers of such.

In thanking you for a sample copy, either current or back number, which I would be pleased to have you send me care Hon. William Remington, Brownsville, Ind., and in awaiting the receipt of your favor in the matter, I am,

Very truly yours,

O. L. REMINGTON,

With William McLean & Co., 317 Flinders Lane, Melbourne, Australia.

SULTANA, CAL., Sept. 28, 1904.

THE IRRIGATION AGE, Chicago, Ill.:

Dear Sir—In glancing over the map of California about midway between Los Angeles and San Francisco may be seen the outlines of Lake Tulare. A few years ago this body of water covered an area sixty miles in length as the crow flies, with an average width of thirty miles. Steamboats from the San Joaquin River found their way into its placid waters through a narrow stream known as the San Joaquin Slough. But today not a drop of water is there to be found in the bed of the old lake.

Kings River, with its source in the Sierra Nevada Mountains, empties into the San Joaquin Slough. What has always been regarded as a peculiar feature of the rise and fall of the waters of the lake, was the fact that the current from Kings River flowed into the lake by way of the slough until a certain level was reached. Then there would for a time be a backing up of the waters of Kings River, an overflow of low lands on either side. Then the current of the slough would simply reverse itself and lake, river and slough would slowly drain into the San Joaquin River. In the last few years irrigation has wrought a great change in the vicinity of the old lake.

Canals have been made that lead out the waters of upper Kings River supplying the necessary moisture for thousands of acres of orchards and vineyards in a section that was formerly an arid plain. Year after year Lake Tulare has grown smaller and yet more small until now it is entirely off the map. The surface of the lake's bottom is almost perfectly level. Lands that have from time to time been reclaimed on account of receding waters have proven wonderfully productive. A sediment having for centuries settled on the lake's bottom gives the soil some of the qualities of the valley of the Nile. The lake's bottom being the property of the State's school fund, it was subject for entry at $2.50 per acre. All of it has been bought and real estate speculators are endeavoring to control large tracts. It is generally considered that it is the richest soil in the State. To guard against a possible inundation a great levee is now being constructed across what was once the mouth of the San Joaquin Slough. This precaution is hardly necessary. Lake Tulare is a thing of the past. Yours, truly,

JAMES W. SWEETMAN.

SACRAMENTO, CAL., Aug. 27, 1904.

THE IRRIGATION AGE, Chicago, Ill.:

Dear Sir—I enclose herewith a bulletin covering the fruit situation in this State which I trust you may find of interest and value. I also enclose a short article on "Irrigation," prepared exclusively for your publication.

We contemplate issuing a regular bulletin to agricultural and horticultural papers throughout the United States and Canada and at the same time sending to certain selected publications exclusive articles similar in character to that herewith enclosed. If you would like to have this service we will take pleasure in supplying it. Our purpose is to obtain publicity for this portion of California for which we desire to give full value.

We propose to send truthful reports without cost to you and we believe a series of articles can be prepared that will be of interest to your readers. We can furnish satisfactory references.

The enclosed are samples of what we propose to do and we trust they will meet with your approval. In case you desire this service please let us know by letter, also please kindly send copies of your publication containing articles.

Yours very truly,

W. A. BEARD, Secretary.

PEORIA, ILL., Sept. 15, 1904.

THE IRRIGATION AGE, Chicago, Ill.:

Dear Sir—You will kindly allow me once more to put in a few words upon this most important topic, irrigation. Your family of thinkers upon this topic is quite large and appreciate your kindness in opening up the pages of your valuable journal for the discussion, both pro and con, of this most important subject of the day. The exchanging of thoughts through the medium of your journal will finally result in a great educational school along this line.

Generally speaking, most of the young men and a great many of the older ones are taking Horace Greeley's advice: "Go west." The cause of this is chiefly the high price of land in their native States. As they go west, they find the same conditions prevailing and the great arid belt before them. Looking over the situation they find the soil and climate very much like that of Southern California and it would be just as valuable, but the lack of moisture makes it worthless. They also realize the great undertaking of the Government to bring thousands of acres of this worthless land into value equal to that of their native States. According to reports, only one-fourth of the arid belt can be irrigated by the flooding and furrow systems. This being the case, makes the number of farms very much limited and not in proportion to the demand.

The question arises, what is to be done with the seventy-five per cent of the arid land that can not be irrigated by the flooding and furrow systems. This is a very vital and important point to be solved in the future. As our population increases, the demand for this land will naturally increase with it. So now is the time to prepare before the demand is upon us. So let us get our heads together and prepare or devise some plan by which this vast amount of uneven arid land can be turned into beautiful homes and in conclusion would say that it stands everyone in hand in the arid West to make a little water go as far as possible. for, according to Professor Cook's recent statement, in Southern California in six years the water had been lowered in the ground about twenty-seven feet. This is enough to cause some alarm. The question is, what will the condition be in ten years should the same decline prevail? Therefore it behooves all to study a more economical system of irrigation and the time is not far distant when many of the fields will have to abandon the flooding system on account of lack of water. So the problem which is really the main issue at this time is to get the best results from the least amount of water. We read of rivers and creeks going dry, water lowering in the ground twenty-seven feet in six years. All this puts us to thinking and well it may, for it means bread and butter and beautiful homes to thousands. These are questions of vital importance to all of us and I trust all will take a hand in trying to solve them.

We don't wonder much at all this when we take into consideration that the flooding system on one acre of ground requires 27,154 gallons to cover the surface one inch. Think of using this amount per acre every ten days during June, July and August and you find out you have a great water problem on hand that is going to tell in the near future.

In my estimation there is only one way to overcome this vast amount of waste and that is by sub-irrigation. Stop feeding the sun fifty per cent of the moisture and your crop gets the benefit. By so doing there will be enough water to go around, thereby doing away with so much contention over water rights, etc.

If I have made any errors in my statements I am willing to acknowledge same through THE IRRIGATION AGE, if pointed out to me. Very truly.

W. A. LEE.

SACRAMENTO VALLEY DEVELOPMENT ASSOCIATION PRESS BULLETIN.

SACRAMENTO, CAL., Aug. 29, 1904.

Shipments of California fruit to eastern points which have passed through Sacramento this season to date aggregate 3,330½ carloads as follows: Cherries. 209 cars; apricots, 96 cars; apples, 8½ cars; peaches. 475 cars; plums, 990 cars; figs, 2 cars; pears, 1,400 cars; grapes, 150 cars; total, 3,330½ cars.

These figures cover almost the entire fruit shipments from the State. The total is considerably less than that of shipments to the same date last year. The shortage is principally in apricots and peaches, these crops being light throughout the State. Apricot shipments last year aggregated 231 cars, peach shipments 1,866 cars.

Cherry shipments are approximately the same as last year. Pear and grape shipments to date exceed those of last year. Grape shipments have barely begun. The crop is heavy and of good quality. The pear crop is unusually large. The prune crop is large and of good quality.

Sacramento Valley oranges promise a good crop of excellent quality and with favorable weather conditions will ripen early as usual. Olives promise a fair crop of excellent quality in Sacramento Valley regions though short in some portions of the State. Almonds will be a short crop and almond prices rule correspondingly high. Figs are yielding a good crop. Canners are using more figs than ever before and fresh fig shipments are increasing.

Fruit prices have as a rule been very satisfactory. Canners have paid good prices for apricots and peaches, thereby reducing eastern shipments. Pears have failed to maintain uniformly high prices, the heavy shipments operating at times to depress values. While this has been an off year in some respects fruit growers have as a rule done fairly well. Sacramento Valley growers who had crops are reported well pleased with returns and as the bulk of California's deciduous fruits are grown in this valley this is true of the majority of growers in this State.

The condition of canned and dried fruit markets is fairly satisfactory except in the case of prunes and raisins. The organization which formerly controlled these crops has gone to pieces through disagreements and the result is a condition which threatens grower's profits.

The grain crop is light, hay crop heavy. In the irrigated alfalfa districts of the Sacramento Valley the fourth crop of hay is now being cut with good prospects of two more cuttings. Hops are yielding heavy crops and prices rule high. Twenty-five cents and upward is offered for choice lots.

STRATHCONA, N. W. T., CAN., Aug. 26, 1904.

D. H. Anderson, Esq., Editor IRRIGATION AGE.

Dear Sir: You will find my name along your list of subscribers in much advertised Alberta—the present Mecca of a good many Americans. "That's all right," as they say out West, but for my part I am going to Washington State as a homeseeker in July next.

I am much interested in an article in the current number of THE IRRIGATION AGE by H. A. Hover, entitled "California of the Northwest." I would like to know more about that particular part of the State than I can learn from that article and would be glad to have you either give me Mr. Hover's address or forward this letter of inquiry to him for reply.

I would enclose American stamp for reply, but I have none nor can I get one here. A reply in the next number of THE IRRIGATION AGE will answer the purpose, but be more trouble to you. Yours respectfully,

W. E. BARTLETT.

SACRAMENTO, CAL., Aug. 27, 1904.

THE IRRIGATION AGE, Chicago, Ill.:

Irrigation development has lately received a new impetus in the Sacramento Valley, which comprises the northern portion of the great interior basin of California. The great Central Irrigation Canal, begun almost a quarter of a century ago, is nearing completion after a long period, during which work was stopped and various interests affected by the canal were in litigation. Other irrigations systems are building and the indications are that the great valley of the Sacramento will at no distant date be rendered vastly more productive through the utilization of the water which has heretofore gone to waste.

The Central Irrigation Canal will divert water from the Sacramento River at a point near St. John in Glenn County, and will irrigate an area of approximately 200,000 acres lying west of the river. The greater portion of this land is now devoted to wheat, but with water for irrigation it will grow a diversity of crops and its productiveness be many times multiplied.

Another important irrigation enterprise will divert water from the Feather River below Oroville and irrigate approximately 100,000 acres lying west of that stream. Work on this system has just been begun. A new irrigation ditch of considerable magnitude is almost completed in Yolo County.

F. E. V.

SOME SALT LAKE HOMES.

These are typical residences of Salt Lake City's wealthy citizens. The home of United States Senator Thomas Kearns was built and furnished at a cost of nearly $1,000,000, while that of H. H. Walker represents about one-half that sum. Both of these residences occupy fine sites on Brigham street, the home of the

Residence of Senator Kearns, Salt Lake City

majority of the rich Salt Lakers. Upon this street there are a score of homes almost as magnificent.

Salt Lake City has always been noted for its natural beauty, healthfulness and commercial prosperity. The last few years, however, have seen the city thoroughly modernized. A great many fine business houses and

Residence of H. H. Walker, Salt Lake City

residences have been added. The streets are clean and spacious and the lawns and residences artistic from every standpoint. The fame of Salt Lake City grows steadily. Capitalists everywhere have come to recognize that it is one of the best places in the country for safe and profitable investments. No more desirable city exists when the question of a residence is under consideration.

SOME ADVANTAGES OF THE ARTESIAN WELL FOR IRRIGATION.

BY S. W. GILBERT,
President of the First National Bank, Artesia, N. M.

In this arid West any permanent supply of water is appreciated. The important questions are the quantity and the quality. There are at present three means of irrigation. First the surface wells, from which the water is raised by pumps run by windmills or gasoline engines. Surface water is obtained at a depth of fifteen to 150 feet below the surface and the supply seems to be inexhaustible. My surface well for domestic use is only thirty-five feet deep. The water stands three and a half feet in a six-inch pipe, but the hardest kind of pumping will not lower the water. For a garden or a small truck farm a man may be successful with surface water. But one need not hope to farm on a large scale with water raised by a windmill.

Second—We have the ditch or canal system taken from the rivers. The rivers are mostly fed by springs and a good head of water is obtained, but it is so often accompanied by that expensive and disagreeable lawsuit that makes company water rights so objectionable. Then another serious objection to co-partnership water is when unscrupulous members live on the ditch and insist that they have "prior right" and want to take water out of their turn. Just a little taken now and a little then does not amount to much at the time, but when summed up it is no worse to steal a man's crop than it is to take his water. I have had all of my water cut off at night and turned on the next morning. Just when you need the water the most some one else needs it just as badly and helps himself.

Next comes the artesian well, which to my mind is the most satisfactory. A man who is fortunate enough to own 320 acres of land with an average artesian well on it has an independent fortune. I say independent because he does not have to depend on any man nor company of men to say when he shall or shall not have water, nor how much he may use. He has his supply always at hand and can use it at his convenience. But some one will say one well is not enough for 320 acres of land and besides they are so expensive. Yes, they are expensive, that is, the first cost is considerable, but you are not compelled to pay a water tax each year, neither are you compelled to help keep the other man's ditches clean. The average well in this part of the Pecos Valley is enough for 320 acres with a good deal to spare. What is being done with some of the large wells? I shall mention only two or three average wells. From February 1st to June 1, 1904, Mr. E. N. Heath had irrigated 250 acres of land two and one-half times. This irrigation was done directly from the well through new ditches. The land had never been irrigated before. This was government land two years ago. Most of the irrigating was done by inexperienced men and consequently a great deal of the water was wasted. Almost the entire 320 acres of land has been planted and Mr. Heath is renting water to his neighbors. This well is 715 feet deep, cased with 7⅝ casing and flows 2,000 or 2,500 gallons per minute.

Mr. J. B. Cecil has a well 830 feet deep, cased with 6-inch standard pipe and the water gushes seven feet above the casing and flows about 2,500 gallons per minute. He is cultivating about 400 acres of land that is planted in corn, oats, barley, alfalfa, and forty acres of orchard. United States Land Commissioner Smith has a well 740 feet deep on 320 acres of land and almost the entire tract is in cultivation. The greatest wonder of wells is that of R. B. Barnes, near the Penasco River. This well is only 530 feet deep and flows five feet above the casing. The well was completed too late to allow of much planting. About ninety acres is being irrigated, however.

The water from these wells is hard, but there is no sulphur, as is found in the wells farther north. The average temperature of the water as it flows from the well is about sixty degrees. Therefore there is no danger of chilling the vegetation directly from the well.

PLAN FOR RECLAIMING VALUABLE WASTE LAND.

Irrigation to Make Fertile 500,000 Acres in North Dakota.—Water Will be Pumped from Upper Missouri and Distributed Through Ditches.

ST. PAUL, Sept. 23.—When certain irrigation plans for North Dakota shall have been put in operation North Dakotans declare that the "slope" country, now a semi-arid region, will be made to blossom like a rose, and that the State will be the richest agricultural State in the Union.

E. A. Williams, United States surveyor general for North Dokota, who is at the Merchants' Hotel, is an enthusiast on the subject of reclaiming the great areas on each side of the Missouri and the Cannon Ball Rivers by pumping the water of the rivers up to the table lands, and distributing it by means of reservoir systems over a great area of lands.

The State has a fund of more than $3,500,000 for the reclamation of the dry lands of the slope country, and the expenditure of only a part of this sum, it is said, will bring under cultivation an area of fully 500,000 acres of lands only awaiting the introduction of a comparatively small quantity of water in addition to the annual rainfall. Said Surveyor-General Williams:

PLENTY OF FUEL AT HAND.

"The cost of pumping water from the level of the rivers to the table lands for subsequent distribution over the prairies, can be kept at a minimum by the presence of great beds of lignite coal found in limitless quantities along the streams and, which, it is asserted, can be mined for a sum insignificant when compared with the cost of bringing coal from the coal fields of Illinois or Iowa.

"There is plenty of water in the Missouri, the Little Missouri and the Cannon Ball, there is coal available for driving the pumps, and only the pumps and the system of irrigating ditches remain to be installed to convert the great area of now almost waste lands into highly productive farms, capable of producing immense crops of every grain grown in the latitude of the State.

"Government engineering experts who have traversed the section of country that I describe say that there is the greatest opportunity for a giant irrigation plant in the country.

THE SCOPE AND PURPOSE OF THE IRRIGATION INVESTIGATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

BY ELWOOD MEAD, IRRIGATION EXPERT IN CHARGE.

Courtesy U. S. Department of Agriculture.

(Concluded.)

IRRIGATION IN THE INSULAR POSSESSIONS OF THE UNITED STATES.

Hawaiian Islands.—During the past summer officials of the Hawaiian Islands requested this office to make such investigation of the irrigation problems of these islands as would furnish the facts needed in framing an effective code of irrigation laws. The need of such legislation is becoming urgent. Large investments in irrigation works to supply water for the growing of cane have made the subject of water ownership and control of one of the most important internal questions of these islands. Proposals have been made by private parties to purchase from the Government all of the water rights attached to public lands. Wise action on such proposals will be promoted by a thorough investigation of agricultural conditions and the prospective needs of irrigators. An agent is now engaged in collecting facts as to the use of water on these islands.

Porto Rico.—Large areas in Porto Rico to be productive require irrigation. Legislation will, therefore, be needed for the establishment of water titles and to protect the holders of these titles in times of scarcity. It is now admitted everywhere that if water laws and land laws had been framed and administered together in the settlement of the arid West many of the complications which now exist could have been averted. The opportunity is now open for inaugurating a comprehensive code of laws in Porto Rico which shall control development from the outset, and it is believed that an investigation to determine the facts on which such laws should be based should be inaugurated at once.

THE NEED OF EARLY AND EFFECTIVE REFORM OF IRRIGATION LAWS.

While the area of land in the West susceptible of reclamation is small when compared to the whole extent of the arid region, it is practically unlimited when rference is had to the water supply. Along almost every stream there is an abundance of irrigable land and a shortage of water. This brings attention to the importance of measurements and experiments to determine how much water is necessary to successful agriculture, and to inaugurate such measures in its distribution and use as will secure the utmost economy. The area ultimately to be reclaimed will depend wholly on the water supply, and any excessive or wasteful use on land already under cultivation deprives other land equally good of that which would give it value, prevents the increase in homes and robs the State and community of taxable wealth. The laws of most Western States have recognized this and prohibited the wasteful use of water, but without greater knowledge they can establish no standard by which to determine what is wasteful use.

The fact that the water supply is the source of all agricultural values also emphasizes the need of an efficient system of public control. Some States have realized this need and have provided for it. Colorado has seventy-five officials, appointed by the governor, whose sole duty it is to see that the water supply is properly distributed. Wyoming has a like system, with forty-eight officials engaged in guarding its water supply. Nebraska also has a similar system. Utah and Idaho have also made partial provision for accomplishing this result. In the other States, where protection is afforded for every other kind of property, water is left to be fought over in the field and in the courts, and even when controversies are settled in this way for one year, the next season of drouth is almost certain to bring a renewal of the conflict. In the localities where those using water from a stream can settle their rights satisfactorily to all concerned, there is nothing to prevent newcomers from building other canals, establishing new rights, unsettling existing conditions, and in this way prolonging the anxiety, uncertainty and controversy indefinitely.

There are other reasons for a prompt and comprehensive study of water-right problems. In every arid State and Territory the acreage of land under ditches already built is largely in excess of the land now being cultivated. In Idaho there are about 1,600,000 acres of land under existing ditches, of which only 600,000 are now being irrigated. In Wyoming there are probably two acres under ditches for every acre that is cultivated. Along the Arkansas River in Colorado and in western Kansas the same conditions prevail. The same is true of the ditches in New Mexico. In the Salt River Valley, in Arizona, the canal systems cover an area of 350,000 acres, of which less than 150,000 are being cultivated. In northern California many completed ditches are only partly used and a few not used at all. The rights to water in most of these States are based upon the estimated capacities of the ditches, and when the lands for which these rights have been acquired are actually brought under cultivation the present difficulties experienced in the distribution of the supply will be greatly enhanced. This makes necessary two things: (1) More effective administrative provisions, and (2) a knowledge of the facts which ought to govern these officials in the performance of their duties. In some of these States the lack of cultivation of the lands under ditches is due to an inadequate water supply. The streams on which they depend have an abundance in the early part of the season, but this is followed by a drouth in July and August. Here the remedy will be found in storage. In other cases, development has simply outrun settlement and only time and effective measures for colonization are required. In others inadequate water laws and uncertainty regarding water titles is the cause of the delay in making use of the facilities already provided. Farmers do not feel warranted in building laterals, planting crops and making contracts for water when the most probable result of this outlay will be an injunction suit. The story told on pages 171-183, Bulletin 100 of this office, shows that this danger is not imaginary.

The investigations of this office have shown that the boundaries of irrigation districts should follow drainage lines, that rights to water should include all the watershed of the stream and that administrative control should not be restricted, as it is now in some States, by arbitrary county boundaries. In several

States county commissioners are made water commissioners; but as many streams flow through more than one county, in some cases through six or seven counties, there can be no adequate or proper supervision. Colorado, Wyoming and Nebraska have each been divided under State laws into irrigation districts based on drainage lines rather than on county lines. This makes possible an effective division of water within the boundaries of these States. Something to supplement State supervision, however, will in time be required. There are interstate questions which can not be ignored, although laws to provide for the proper division of water within a State are a more vital and urgent necessity than measures to settle the division of interstate streams. The study of interstate rights should, however, begin at once. It will be most unfortunate for all concerned to delay this study until the gravity of the issues created shall result in hasty or ill-considered legislation. What is needed is a careful and impartial investigation of this question by competent engineering and agricultural experts. The problems to be solved are primarily agricultural and engineering. The first questions to be determined are: Where is water now being used? Where can it be used to best advantage? What are the character and extent of vested rights? These matters ought to be settled by the dispassionate, unbiased study of experienced men and not left to be fought over in the courts by warring private interests. It is impossible for Congress to legislate regarding water rights within States without revolutionizing existing conditions in some of the States, and without interfering with vested rights. The differences between State laws and in the character of the rights established under those laws make such a result inevitable. But a commission could determine what proportion of a stream should flow down from the State above to the State below and leave it to the authorities of the State above to determine what measures shall be taken to accomplish this result, and to the authorities of the State below to determine what shall be done with the water when they receive it. In this way there would be no interference with vested rights or with State codes of laws, while at the same time there would be a far better prospect of securing a just and effective division of the supply than through interstate litigation such as is now impending.

PLANS FOR IRRIGATING 9,000,000-ACRE TRACT.

An irrigation project which, if carried out, will reclaim more than 9,000,000 acres along the Missouri River in North Dakota and will add approximately $350,000,000 to the real estate valuation of the State, is under consideration by the officials of North Dakota and the Department of the Interior at Washington. Chief Newell, of the United States Bureau of Geological Survey, and a party of government officials passed through St. Paul on the way to North Dakota, where they will inspect the land along the Missouri River and determine to what extent irrigation is feasible.

It is reported that the investigation is being made with the approval and sanction of President Roosevelt, who is especially interested in reclaiming the semi-arid lands of the Northwest through irrigation. The president once had a ranch in North Dakota and at that time discovered the possibilities of irrigation. He discovered that the soil is among the most fertile in the world; that the Missouri River furnishes ample water for irrigation; that there are abundant quantities of lignite coal along the river to furnish power for pumping water into reservoirs, and that owing to the natural resources of the country it is peculiarly adapted to irrigation.

The tract which it is proposed to irrigate is fifty miles wide and extends 300 miles from the Montana line along the river. The soil is as fertile as in any section of the United States, and it is estimated that land which is now worth only from $3.00 to $4.00 per acre will be worth from $40 to $50 when irrigated. The soil is unusually well adapted to the raising of cereals, all kinds of vegetables and sugar beets, as according to the analysis of experts it contains 22 per cent saccharine matter. Potatoes raised on similar soil are mealy and dry, and wheat and other grains are famous the world over for their good qualities.

"Irrigation can be put into operation in North Dakota more effectively and at a less cost of maintenance than in any other section of the United States," said one of the leading business men of North Dakota, who was at the Merchants Hotel recently. "The rainfall in the section along the Missouri River is almost enough to raise good crops, so that not a great amount of water has to be spread on the land through irrigation. The land has a clay subsoil and does not require so much water as is required in Arizona, Nevada, California and other Southwestern States. Experts who have inspected the land say that in the dryest season one or two soakings will be sufficient to raise the finest crops in the country. This year there has been plenty of rain, and specimens of a bumper crop have been on exhibit at the Minnesota State Fair and will be taken to St. Louis.

"Expert irrigation engineers who have investigated the project say that sufficient water can be obtained from the Missouri River to irrigate the entire 9,000,000 acres. For 250 miles along the river there are banks of lignite coal, which can be mined at merely nominal cost. The banks of lignite extend into the river from four to thirty feet, thus insuring an abundant quantity of fuel for steam power. Lignite coal can be obtained at 80 cents a ton.

"According to the opinion of these engineers, who have investigated irrigation in all parts of the United States, it is feasible to raise the water 150 to 200 feet in reservoirs which will contain enough water to last six months. Central plants can be installed near the river, and by means of electricity the power can be distributed all over the 9,000,000-acre tract at little cost. The land is rolling, so that it can be flooded with water by the force of gravity. In this way irrigation can be carried on at much less cost than in Arizona, where it is necessary to force the water over the land by pumping, and in Nevada, where it is necessary to cut down the mountains to secure a passageway for the water.

"No one who has not visited this section of North Dakota has any idea of the fertility of the soil. It is adapted to the raising of all kinds of fruit, including apples, plums and grapes, and the climate is better than in the Red River Valley, and, in fact, many people believe that it is better than in southern Minnesota. Lands which now are suitable only for grazing when irrigated, will make the finest farms in the Northwest and worth from $40 to $50 an acre.—*St. Paul Pioneer Press.*

IRRIGATION EXPERIMENTS IN ARIZONA.

Investigations Covering a Period of Four Years at the Experiment Station Farm at Tucson.

BY PROF. ALFRED J. M'CLATCHIE,
Agriculturist and Horticulturist of the Arizona Agricultural Experiment Station.

(Continued.)

The method of providing for the irrigation of sugar or garden beets depends upon the time of the year they are sown. If planted during the cool part of the year—November 15 to the first of March—they may be sown just as they are in regions where they are not irrigated, and furrows subsequently made for their irrigation. But if they are planted at other times of the year it is necessary to sow the seed along previously made furrows, or to make furrows as the sowing is done, since a good stand can not be secured during dry weather without irrigation. If the seeding is done during the cool part of the year the crop will need no irrigation for a month or two. If the seed be sown during the warm weather of early fall the crop will need frequent irrigation until cool weather arrives. If sown during the warm weather of spring irrigation will be necessary during the entire period of growth. It is not usually advisable to sow either sugar or garden beets so late in spring that they must be grown entirely by irrigation.

Beets do best sown during September, October, January and February. At whatever times during these months the seeding is done, the crop makes the most of its growth during the cool part of the year, and is grown with a comparatively small amount of water. During ordinary years the greater yield will be obtained with the same amount of water the earlier they are sown after the coldest weather is past. The coldest weather of the winter 1899-1900 occurred before Christmas, and the beet sown December 26 porduced better results than those sown later and given the same amount of water. The year previous those sown during January produced a larger yield than those sown during either December or February and given the same amount of water. The same year a yield of nearly ten tons per acre was secured by the use of about one foot of water previous to sowing the seed and of about .5 of a foot applied about two and one-half months afterward—1.5 feet in all. This was in a fine adobe soil, quite retentive of moisture. To produce the same crop in a gravelly, porous soil required the use of nearly three feet of water.

CABBAGES.

After the plants have been raised in beds in the usual way they are set along furrows that have been recently wet or through which water is run immediately after setting. In either case the individual plants are usually watered by hand as they are set. Plants are set out from September to November inclusive, and during January and February, from seed sown a month or two previous. The furrows along which they are set are usually permitted to remain until the plants are well established. They are then cultivated up and made afresh for each subsequent cultivation. During the early stages of growth they are run near the plants, but later are run midway between the rows. Reference to Table V will show that cabbages require a large number of irrigations.

While this crop is grown mainly during the cool part of the year, when evaporation is comparatively slow, yet the large part of the soil left unshaded by the crop, there being thus little check to evaporation therefrom, and the shallow rooting of the plants, thus requiring frequent irrigation, cause the need of a comparatively large amount of water to produce a crop. Also, in order to thrive they need to have the soil kept moister than do many other crops. It will be seen that a total of five feet was applied during the sixteen irrigations.

CORN.

Corn is planted in soil that has been previously irrigated, in some cases with a combined lister and drill, but more usually along small furrows through which water has been previously run and that are left for the first irrigation. Some farmers, however, drop the seed into each third or fourth furrow as the land is plowed. When the corn has come up and the water applied previous to plowing and planting has evaporated, furrows are run between the rows for subsequent irrigation.

For table use, corn is planted during February, March, July and August. Field corn is planted during July only in this region. When planted at this time four to six irrigations of about 0.4 of a foot each are necessary to produce a crop. It will be noted by reference to Table VI that all the water the corn grown during 1901 received was applied during the first two months after planting, no irrigation being needed while it is maturing its ears. It will also be noted that the total amount applied was just about the same as that necessary to grow a crop of wheat.

COWPEAS.

Cowpeas may be planted in hills along furrows that have been previously moistened, and through which they are irrigated the first time; they may be sown in drills and irrigated through subsequently made furrows; or they may be sown broadcast, disked in and irrigated by flooding. Whatever the method of planting and irrigation, they require quite frequent irrigation.

The amount of water necessary to grow a crop of cowpea hay is so great, as compared with the amount necessary to produce the same amount of alfalfa hay, a nitrogenous forage of equal value, that its production can scarcely be profitable in any part of the Territory where the amount of water used is an object. The need of this great amount of water is due to the fact that the plant must pass through all of its stages from germination to maturity during the warm part of the year, when the loss of water from the luxuriant foliage and from the soil is rapid. The same amount of foliage produced during the cool part of the year would not require much over half the amount of water needed during the summer. However, where the water supply is ample cowpeas may be grown to advantage between two crops of grain.

GRAIN.

There are two methods of putting in grain in southern Arizona. Either the fields are plowed quite dry and, after being harrowed, seeded in this condition; or the fields are thoroughly irrigated before plowing and the seed sown in moist soil. If the former

method is used, irrigation as soon after sowing as possible is necessary to cause germination of the seed. If sown in moist soil and covered deeply with an ordinary harrow or with a disk harrow it will usually germinate well and make a good stand without irrigation following the sowing. The results from the two methods of putting in grain are consequently quite different. Irrigating the dry soil after sowing the grain causes it to bake and the surface to remain in a hard condition, unless a harrow is run over the field before the grain is too large to be injured, and in any case the condition of the soil is such that another irrigation will be needed before that sown in moist soil will show the need of water. The compacting of the soil by irrigation following seeding causes a loss of moisture more rapidly than from the fields sown in the other way, hence the consequent need of earlier and more copious irrigation. Fields in which the seed is sown in moist soil usually need no irrigation for two or three months, during which the grain will make an excellent growth and send its roots deeper than in soil that has been irrigated soon after the sowing of the seed. By the time the moisture stored in the soil before sowing is evaporated from the soil and from the plants the surface of the field will be covered by the growing grain. Consequently when water is applied evaporation from the surface of the soil is not as rapid as it would be from bare soil, and the soil does not bake, as in the case of that irrigated when bare. Hence the soil of such fields remains in much better condition than that in those irrigated soon after seeding, and the grain has an opportunity to make a better growth and give a larger yield.

It will be noted by referring to Table VI that the wheat sown in moist soil not only required less water to bring it properly to maturity, but gave a greater yield. The amount of water used was about a seventh greater on the field sown dry, while the yield was about a seventh less than from the other field. This makes quite a difference in the net returns per acre, as well as in the net returns per foot of the water applied.

Grain sown in soil that has been thoroughly moistened to a depth of two or three feet by the application of one-half to three-fourths of a foot of water will need no irrigation until March or April—depending on the season—and will need but one or two subsequent irrigations to produce a good crop. As long as the young grain is making a thrifty growth, water should be withheld. When it begins to wilt slightly during the heat of the day, or about the time it begins to send up grain stalks, water should be applied. The last irrigation should be given just about the time the grain is in the milk. If given water between these two irrigations it should receive only enough to keep it growing thriftily, but not enough to make it unduly rank.

It will be observed that the amount of water used in growing grains is comparatively small. This is due to the time of the year during which these crops are grown here, the season of sowing extending from the early part of November to the middle of February. The summer being too hot for them, they are grown during the cool part of the year, most of the growth being made from January to April, when evaporation is comparatively slow. Crops of grain are sometimes grown with the application of much less water than given in the tables. As stated above, it is necessary either to irrigate the soil thoroughly before plowing or to irrigate soon after sowing the seed. With one irrigation subsequent to this, a good crop can sometimes be grown in soil retentive of moisture, the total amount applied not having exceeded one foot. This possibility of growing grain here during the cool part of the year enables us to produce a crop with less water than in cooler, less arid States, where the crop is grown during the warm part of the year.

GRAPES.

The first season after setting, grape vines need frequent irrigation throughout the season, to enable them to become well established. Two irrigations a month will be beneficial in porous soils, and one irrigation per month should be given in most other soils. The second season the vines will do well with less frequent irrigation. During later years the greater part of the water needed to produce a crop may be applied during the winter—from January to March, inclusive. Water to the depth of two feet may be applied to advantage in most soils during this period.

When the blossoms begin to open water should be withheld until the young fruit is about the size of peas. One or two thorough summer irrigations will be ample to produce a good crop. No water need be applied from August to January. The total amount needed during the year is not over three feet.

MELONS.

Melons are planted during March along previously moistened furrows. For watermelons the furrows are made eight to ten feet apart, and for muskmelons, about six feet apart. Water is run through the furrows, and about two days later the seed is planted along one side, just above the water line. During favorable weather no further irrigation is necessary until after the young plants appear. But if the weather following planting be too cool for the germination of the seed, the soil about them will often become too dry. In such a case an irrigation a week or two after planting will be important. After the first irrigation the furrow should be cultivated up and a fresh one made for subsequent irrigations, which should occur about twice a month during the first two months. Thereafter more frequent and more copious irrigations will be desirable.

While watermelons and muskmelons require a large number of irrigations during their growth, the amount applied to the crop is not correspondingly large, as is shown by the record of the water applied to the watermelon crops grown during the past two years. This is due to the distance between the rows and to the fact that during the early part of their growth only the furrow along which they are planted is moistened. Thus, during the first half of the life of the crop, only a small portion of the soil is kept moist; and at no part of its growth is all the surface commonly moistened. Furthermore, the vines grow so rapidly that undoubtedly a larger proportion of the water is used by the plants and a smaller proportion lost from the soil than is the case with many crops. The covering of the surface by the vines would also cause less loss from the soil. Thus, a crop consisting of a product containing a large amount of water is produced with an amount of water that is smaller than might be expected.

ONIONS.

Onions are irrigated through furrows, or by flooding, the former method being preferable in most soils. Seed is sown during September and October, either

broadcast in beds from which they are to be transplanted, or in drills eighteen to twenty-four inches apart. From the time of planting until near the time of harvesting they need to be irrigated frequently and to be cultivated after each irrigation. As stated in Table V, the crop of 1899-1900 received twenty-nine irrigations.

The growing of onions involves the use of a large amount of water, as well as the expenditure of much labor. Though they are shallow-rooted and do not require that the soil be deeply irrigated, they must be irrigated through such a long period—about ten months—that a large amount of water must be applied to produce a crop. A large percentage of this is lost by evaporation. It will be observed that only about two-tenths of a foot was applied at each irrigation, enough to wet the soil only eight to ten inches deep. Nearly all of the water of the upper two or three inches would be lost by evaporation, as well as considerable of what reached the soil below this stratum.

FROM FIELD TO DINING TABLE.

All Features of Rice Culture, Milling Processes and Rice Food Preparation to Be Seen at the St. Louis Fair.

(Special Correspondence IRRIGATION AGE.)

ST. LOUIS, MO., Oct. 1.—Rice and rice culture will be fully represented and all the by-products of rice displayed at the Louisiana Purchase Exposition. All methods of milling rice, from the primitive in China to the modern in the United States, will be demonstrated by exhibiting the wooden blocks and pestles and other appliances on through the various stages of progress to the latest up-to-date machinery in operation.

Rice is given a place of honor as one of the five special exhibits in the Agricultural Palace, and will be placed in the great central nave of that giant structure. The state of Louisiana, which alone furnishes the cane sugar portion of the special sugar exhibit, will also provide the entire special rice exhibit. Louisiana will demonstrate to the world that her possibilities for rice culture are unexcelled because of the fact that her lands and climate are especially adapted to rice growing, where irrigation for this cereal can be done satisfactorily. This special rice exhibit will be favored with a unique installation, and will be one of the star attractions in the Palace of Agriculture.

The very word "rice" brings to the mind of the average man a picture of John Chinaman and his chopsticks, and comparatively few people realize the recent rapid growth of rice culture in this country. Owing to climate and soil conditions Louisiana and South Carolina are the two States that have stepped to the front in the cultivation of this important cereal. Texas is showing progress in the same field.

Taking the whole world in view, rice is the chief diet of more people than depend upon any other cereal. While the origin of rice is unknown, it is generally conceded that the cereal was first cultivated by the Chinese. History records that the first rice culture in America began when a half bushel of the grain was sent over from England to the Virginia colony in 1647. From this a yield of sixteen bushels was obtained. But the Virginia settlers allowed the rice industry to lapse, and devoted more attention to tobacco growing, which had secured a firm standing from the time the colonists had bartered so many pounds of the weed for wives almost forty years before.

By a fortuitous accident the rice industry was given a substantial start in 1694, when a ship bound for Madagascar was driven by a storm to seek shelter in the harbor at Charleston, S. C. The ship's captain happened to find an old friend in the person of Thomas Smith, governor of the province, and presented him with a sack of rice. Rice culture was then started successfully, and South Carolina for more than a century held the primacy of States in rice production. But Louisiana now stands first, with an annual production of nearly 173,000,000 pounds, and South Carolina second with 47,500,000 pounds. Up to the beginning of the civil war the Carolinas and Georgia produced most of the rice in this country, but the industry was completely paralyzed during the war, and at its close the rapid development was transferred to Louisiana, where improved machinery has been used to a greater extent than in other rice-growing States. This country now produces over 250,000,000 pounds annually.

Louisiana will astonish the thousands of visitors to the World's Fair by her special rice exhibits by showing all the processes in rice culture, from the field to the mill and from the mill to the dining table. Machines used in harvesting rice and the advanced milling processes will be demonstrated. The old-time processes will be seen also. The primitive method of milling rice in this country, and which still obtains in China, is to place a small quantity of the grain in a hollow stone or block of wood and pound it with a stone pestle. The blow cracks the hull, and the friction created by the sliding motion of the rice under the pestle removes the hull from the cuticle. The hulls and bran are blown aside by winnowing. In Oriental countries a large hollow log is now used as a mortar, and the pestle is a heavy pounder attached to a horizontal beam six or eight feet long, resting on a fulcrum. Fanning mills are used now in the Orient.

The rice of commerce grown in the United States is milled by modern machinery, which will be seen in operation, as far as possible, in the special rice exhibit by Louisiana. The hulls are removed by rapidly revolving millstones, and are separated from the grains by screen and blowers. The rice then passes to other hullers to remove smaller particles, and then the flour and bran separated and the grain passed to cooling pans to remain eight or nine hours. Then comes a process which is really detrimental to the grain as a food product, and that is the polishing of the rice. It is passed through revolving screens with brushes, or with wire gauze and sheepskin. This gives the rice grain a fine, glossy luster and makes it sell at a higher price on the market, but, as a matter of fact, it lessens the nutritive value by taking away nearly all the fats which are found in the outer surface of unpolished rice.

Rice flour and bran, used as feed for cattle and hogs, will be exhibited. Rice flour, mixed with wheat and rye flour, will be made into delicious rice cakes and served with fine syrups, also from Louisiana's sugar exhibit.

The Germans use rice in making an imitation ivory, which in turn they employ in manufacturing cheap jewelry and doll heads. The Austrians make shirt buttons from rice. Starch, cement, paper and similar products are also made from it in European

countries. In America ice companies, canned goods factories and crockery houses are now using rice hulls for packing their products.

Visitors to the fair can also go to the "Rice Kitchen" on the grounds and enjoy a meal composed of rice prepared palatably in many forms.

AN IMPORTANT IRRIGATION WORK.

The Secretary of the Interior has tentatively approved plans for a stupendous irrigation project to be constructed in the valleys of Payette and Boise Rivers, in southwestern Idaho. This information will be especially interesting to those who are familiar with the publications of the United States Geological Survey. One of the most recent geologic folios issued by the Survey is that relating to the Nampa Quadrangle, which is situated near the lower end of Snake River Valley, mostly in Canyon County, Idaho. Mr. Waldemar Lindgren, author of the folio, states that in this region, owing to the lack of rainfall, vegetation is scant, and the entire quadrangle may be called a sagebrush desert. He calls attention to the fact that, with the exception of the flood plains of the Boise and Payette Rivers, tributaries of Snake River, where there is a natural subirrigation that keeps vegetation growing, and some places along Willow Creek, where underground water provides similar subirrigation, the agricultural lands of the quadrangle must be irrigated. In view of this great need, it is gratifying to learn that work has been begun to bring under one comprehensive national irrigation project 372,000 acres of land, or more than the total irrigated area of Arizona, Washington, or New Mexico. In compliance with a request from the majority of the land owners of the Boise and Payette Valleys, the Secretary of the Interior has ordered a continuance of the surveys and investigations preliminary to actual construction work. A sufficient sum for the completion of the work will be set aside as soon as the settlers perfect the necessary organization to secure to the reclamation fund the return of the money required for the undertaking.

The project comprises two features, a masonry dam in Payette River and works for the diversion of water from Boise River. Associated with the dam in Payette River is a canal on each side of the stream, that on the south side connecting with a large pumping plant. The dam will be ninety feet high, 450 feet long on top, and 125 feet long on the bottom. The capacity of the reservoir will be 190,000 acre feet. The north side canal will have a length of twenty miles, the south side forty miles. The estimated cost of these works is $1,200,000. By means of them 1,000 cubic feet of water may be diverted every second for the irrigation of 150,000 acres of land.

The works for the diversion of waters from the Boise River consists of a dam ten feet high, 400 feet long on top, and 400 feet on the bottom, constructed of concrete, steel and timber. The capacity of the reservoir will be 150,000 feet. Two diversion canals, one on each side of the river, will have a combined length of 135 miles and a bottom width varying from forty-five to ninety feet. The estimated cost of this section of the project is $2,000,000, making the cost of the entire project $3,200,000.

No other region of the United States presents a more attractive field for the engineers of the reclamation service.

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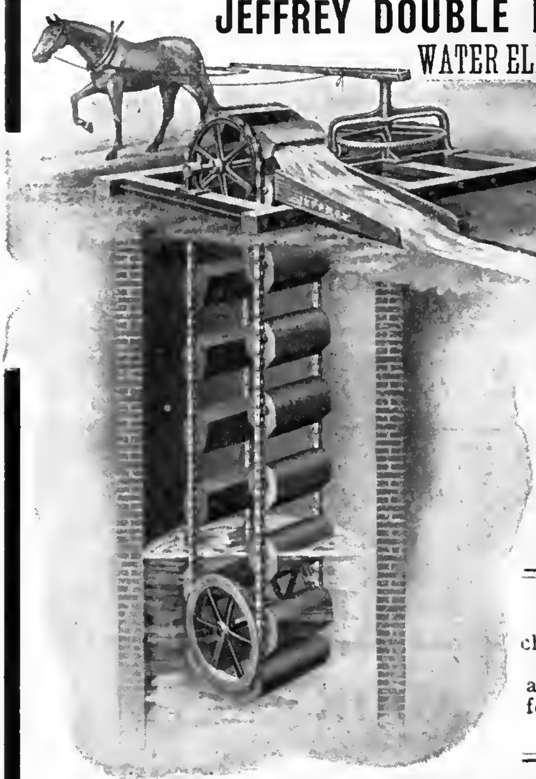

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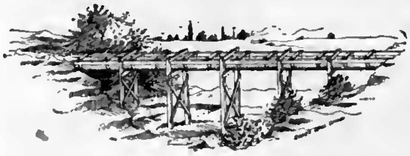

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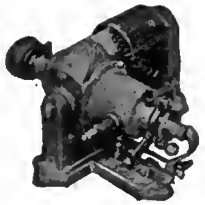

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